Bottom Trawl Survey of Young-of-the-Year Lingcod (*Ophiodon elongatus*) in the Strait of Georgia, July 13 – 26, 2004

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BOTTOM TRAWL SURVEY OF YOUNG-OF-THE-YEAR LINGCOD *(Ophiodon elongatus)* IN THE STRAIT OF GEORGIA, JULY 13 – 26, 2004

by

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ABSTRACT

Haggarty, D.R., King, J.R., Surry, A.M., and Mathias, K.L. 2005. Bottom trawl survey of young-of-the-year lingcod (*Ophiodon elongatus)* in the Strait of Georgia, July 13 – 26, 2004. Can. Tech. Rep. Fish. Aquat. Sci. 2589: 53 p.

In July 2004, we conducted a bottom trawl survey for young-of-the-year lingcod (*Ophiodon elongatus*) in the Strait of Georgia. We found significant and striking differences in young-of-the-year lingcod catch densities between the northern and southern regions in the Strait of Georgia, with far fewer fish found in the south. This pattern is consistent with previous surveys conducted in 1991 and 2003. This year's survey was expanded to include sites on the eastern side of the Strait of Georgia; however, limited comparable habitat was available, as the shores tend to be steeper and rockier. No young-of-the-year lingcod were caught in the eastern strait. We observed an increase in young-of-the-year lingcod density in the northern Strait of Georgia in 2003 and 2004 over 1991. Greater spawning biomass in the northern Strait of Georgia and/or increased larval and post-larval survival due to a more favourable ocean regime may explain the increased young-of-the-year lingcod densities.

RÉSUMÉ

Haggarty, D.R., King, J.R., Surry, A.M., and Mathias, K.L. 2005. Bottom trawl survey of young-of-the-year lingcod (*Ophiodon elongatus)* in the Strait of Georgia, July 13 – 26, 2004. Can. Tech. Rep. Fish. Aquat. Sci. 2589: 53 p.

En juillet 2004, nous avons effectué un relevé au chalut de fond des morues-lingues (*Ophiodon elongatus*) de l'année dans le détroit de Georgia. Nous avons constaté des différences frappantes et significatives entre les densités des prises de jeunes de l'année dans le nord et celles dans le sud du détroit de Georgia, la morue-lingue étant beaucoup moins abondante dans le sud du détroit. Ces résultats concordent avec ceux de relevés effectués en 1991 et en 2003. Le relevé de cette année a été élargi afin de comprendre des sites du côté est du détroit. Ce côté compte cependant un nombre limité d'habitats comparables puisque la côte a tendance à être plus abrupte et plus rocheuse. Aucune morue-lingue de l'année n'a été capturée dans l'est du détroit. Nous avons observé une augmentation du nombre de jeunes de l'année dans le nord du détroit en 2003 et en 2004 par rapport à 1991. Une plus grande biomasse de reproducteurs dans le nord du détroit ou un taux de survie plus élevé des larves et des post-larves dû à un régime océanique plus favorable pourraient expliquer la hausse du nombre de jeunes de l'année.

INTRODUCTION

Lingcod (*Ophiodon elongatus*) populations in the Strait of Georgia have been severely depressed for several decades (King 2001; King and Surry 2000; Richards and Hand 1989). The population reached historic lows in the late 1980's which continued throughout the 1990's despite management measures implemented in 1990 (King *et al.* 2003). Since 1990, the retention of lingcod by the commercial fishery in the Strait of Georgia (Minor Statistical Areas 13-19, 28 and 29) has been prohibited in response to conservation concerns (Richards and Hand 1989). The recreational fishery has also been subject to regulations. Prior to 2002, recreational fishing regulations to protect lingcod included an eight month winter non-retention period to protect nest-guarding males, size limits, and reduced daily and annual catch limits. In 2002, the recreational fishery was closed for the retention of lingcod as an additional measure to protect this stock; the non-retention regulation currently remains in effect.

Assessing the success of management strategies requires reliable measures of changes in the relative abundance of lingcod. In 2003, a young-of-the-year lingcod survey was conducted as one component of a monitoring and assessment program for Strait of Georgia lingcod (King *et al.* 2003; Haggarty *et al.* 2004). The purpose of the 2003 bottom trawl survey is to index the relative abundance of young-of-the-year lingcod in the Strait of Georgia and to compare mean and median densities (using number of fish caught per area swept) of young-of-the-year lingcod to those found in a prior studies conducted in 1991 (Workman *et al.* 1992). This survey was repeated in July of 2004 to assess the 2004 lingcod year class strength and to compare it to the 1991 and 2003 data. Yearly lingcod recruitment estimates are paramount to assessing if the depressed Strait of Georgia lingcod stock is recovering.

Lingcod spawning begins in December and continues into March with the peak spawning activity in late January to early February (Low and Beamish 1978; Wilby 1937). Male lingcod maintain nest sites typically in rock crevices or ledges where there are strong currents (Low and Beamish 1978). Once the egg masses have been laid and fertilized, the males guard the eggs until they hatch 5 to 11 weeks later (Low and Beamish 1978). Larvae begin to hatch in early March through late April, at a length of about 6-10 mm (Phillips and Barraclough 1977). In late May or early June, the larvae form dense near-shore schools in particular locations as described by Phillips and Barraclough (1977). At this time, the post-larval lingcod are approximately 50-70 mm and have become demersal, inhabiting areas near kelp or eelgrass beds (Phillips and Barraclough 1977). By the middle to end of the summer, young-of-the-year lingcod in the Strait of Georgia are found in a wider range of flat bottom areas, and by age-2 begin to inhabit similar, rocky substrates as older lingcod (Cass *et al.* 1990). Typically, larger lingcod inhabit deep banks and reefs, while smaller lingcod inhabit shallow waters and banks (Forrester and Smith 1974).

In 1991, index sites of suitable young-of-the-year habitat between Sidney and Cape Lazo were sampled. Lingcod are found on flat sand and mud bottoms during their first

summer. Bottoms with combinations of mud, sand and gravel substrates were sampled in 1991. Due to the highly variable catches over purely muddy bottoms in the 1991 survey (King *et al.* 2003; Workman *et al.* 1992), muddy sites were excluded in 2003 and 2004. In 2003 we also expanded the survey North of Cape Lazo to Campbell River. In 2004, the geographic scope of the study was expanded by surveying areas on the eastern side of the Strait of Georgia, between Vancouver and Powell River. Unfortunately, suitable habitat in the appropriate depth ranges (15-24 and 25-34 m) was extremely limited along the eastern shore of the Strait of Georgia.

METHODS

This survey took place at index sites in shallow waters of the Strait of Georgia. We revisited index sites that were sampled along the western portion of the Strait in 2003 and 1991. We also searched the eastern shore of the strait (between the Fraser River and the top of the Sunshine Coast) for areas with suitable habitat in appropriate depths in which we could trawl. Suitable habitat was limited due to the steeper, rockier shores on the eastern side of the Strait of Georgia. The presence of abundant recreational and commercial crab pots in some of the suitable habitat further limited our tow locations.

As in 2003, this survey was conducted aboard the CCGS *NEOCALIGUS*, an 18.8 m-long Coast Guard research vessel with a net tonnage of 48.3 t. The 1991 survey was conducted aboard the *R/V CALIGUS*, which is no longer in service. The net specifications have remained the same for all survey years (see Appendix figures 1 and 2 for complete net diagrams): a Marinovich flat trawl with a 13 m (43 ft) footrope, a 12.5 m (41 ft) headrope and a 1 cm mesh codend liner. In 1991 and 2003 the net was constructed with nylon, but in 2004 a polypropylene net was used. This material improves durability, but is unlikely to alter the catchability of the net. The net was rigged with seven 20 cm plastic floats on the headrope. Tevron steel doors (1.5 m by 1.5 m, 350 kg) provided an estimated 13 m horizontal opening. Two wires were used to deploy and retrieve the trawl net

In 2004, the footrope usually used by the lingcod program was not available. In previous years' surveys, the lingcod survey used a 13 m footrope which has a 10 cm section of 10 cm (4") rubber disks at each end with 6.4 cm (2.5") rubber disks between each end section. The footrope used in 2004 is a 13 m footrope with a 45 cm section of 13 cm (5") rubber disks at each end, followed by a 45 cm section of 7.6 cm (3") rubber disks (Appendix figure 3). This footrope is used for shrimp trawl surveys in conjunction with the same Marinovich flat trawl net as used in the lingcod survey. To calibrate this change in gear, a footrope calibration experiment was undertaken August 22-23, 2004 (see below).

Bottom trawl tows were 10 minutes in duration. Start and finish locations, times, and depths were recorded for each tow. Tide height and substrate type was also recorded. Substrate type was determined from a combination of nautical charts and reflectance readings from the depth sounder. Substrate types are described in terms of sand (S), mud

(M), and rock (R), or combinations thereof. Additional habitat characteristics of the site, such as plentiful kelp, sponge or other invertebrates in the net were also noted.

As in previous surveys, two main depth strata were sampled: 1=15-24 m; 2=25-34 m. We tried to fish two tows per depth strata, per site; however, four suitable tows could not always be found at each site due to limited habitat or space. In order to assess the depth distribution of young-of-the-year lingcod, two additional tows were made in a deeper depth stratum 3=35-46 m at Qualicum Beach and one tow in the Nanaimo area.

Where possible, we revisited the sites sampled in the 1991 and 2003 surveys (Workman *et al.* 1992; Haggarty *et al.* 2004). As in 2003, we rejected most pure mud sites because catches were highly variable (King *et al.* 2003; Workman *et al.* 1992). Other areas were not accessible to trawling due to sport and recreational crab gear or due to high traffic. The survey was expanded to include the eastern Strait of Georgia. Additional sites were chosen by examining nautical charts for areas with appropriate depth, slope and substrate.

There is limited trawlable ground in the suitable habitat and depth range in the southern and eastern parts of the Strait of Georgia. In these areas, tows were made wherever possible. Along the north-western shore, between Campbell River and Comox, there is ample suitable and trawlable habitat. In this area, we randomized the tow location by overlaying a 1 km x 1.5 km grid onto the nautical chart and manually picking blocks in each depth stratum using coordinates chosen with a random number table. We rejected a block if the habitat was not suitable or it was not a trawlable location (as determined by the skipper/fishing master) and replaced it with another random block.

We weighed the total catch to the nearest 5 g. The total catch was sorted for lingcod, kelp greenling (*Hexagrammos decagrammus*), whitespotted greenling (*H. lagocephalus*) and rockfish (*Sebastes* spp.) which were retained for biological sampling. Depending on the total amount caught, three to six baskets out of the total catch were randomly retained for sub-sampling. The remaining fishes were weighed and discarded. The sub-sample was then sorted by species and each species was weighed and counted. The weight and count of each species in the sub-sample was then expanded to the total catch weight (Table 1).

All lingcod were sampled for length (mm) and weight (g). Dorsal fins of lingcod which appeared to be from the age 1+ year class (i.e. fish > 250 mm) were collected for age determination. We calculated the Condition Factor of the young-of-the-year lingcod using the following formula: Weight (g) • length^{-3} (mm) (Caillet *et al.* 1986). We examined stomach contents from a sub-sample of young-of-the-year lingcod by randomly sampling 20 individuals per depth stratum in the northern region, and all individuals in the southern region. Stomachs were opened and the primary, secondary and tertiary prey items were identified to lowest taxonomic category possible, or assigned a general grouping (e.g. fish remains). The volume (cm^3) of each prey item was estimated using a graduated cylinder or syringe. Each prey item was also assigned a digestion code (1 = fresh, 2 = 25% digested, 3 = 50% digested, 4 = 75% digested, 5 = fully digested). For each primary and secondary prey item, we calculated its frequency of occurrence (percentage of stomach contents containing the prey item); the mean and standard

deviation of the volume; the percent volume (the percentage ratio of total volume of the prey item consumed by all fish to the total volume of all prey items consumed by all fish); and the percent contents (the average percentage of the individual volume of stomach contents that were made up of a prey group). Empty stomachs and stomachs with unidentifiable remains were removed from the analysis.

We measured the length (mm) and weight (g) of all whitespotted and kelp greenling and collected otoliths, dorsal fins and scales for age determination. All rockfish were retained for sampling in the lab. Time permitting, we measured the length (mm) of abundant species of flatfishes or other abundant species present in each tow. We also determined the sex and length (mm) of spiny dogfish (*Squalus acanthias*) and skates (*Raja* spp.).

We calculated the catch density of young-of-the-year lingcod using the catch per area swept (number of individuals caught • (length of the tow • width of the net)$^{-1}$). As in 2003, we assumed a maximum spread of the net was achieved (13 m, i.e. the length of the footrope); however, net mensuration equipment was not available to confirm this assumption. Relationships between density and regions, sites, depths, substrate and tide, as well as length and weights were investigated using non-parametric ANOVA (Kruskal-Wallis test) or non-parametric t-test (Mann-Whitney test) using the statistics package Statistix. Data from this survey were compared to data from the 1991 and 1003 surveys using the Kruskal-Wallis (test statistic H) and Mann-Whitney (test statistic U) tests.

Footrope Calibration

To calibrate the change in footrope, we conducted parallel tows along two transect lines, on August 22 and 23, 2004 (Figure 1). The calibration work was conducted at Qualicum Beach, as it has ample suitable towing area, produced catch rates with low relative variability in the July sample (Coefficient of Variation per depth strata was 12%), and is within close proximity to Nanaimo. The limited time we had to conduct the calibration work made it impossible to sample each depth stratum, so the tows were instead made as close to 25 m as possible (22-27 m) i.e. the depth between the two depth strata of the survey. Tows were each 10 minutes in duration and between 0.35-0.4 nm at a speed of 2 knots (over ground). Tows were made between 13:00 and 20:00 on the first sampling day and between 12:00 pm and 19:00 pm on the second day to avoid any temporal variability associated with time of day. Ten tows were made each day: five tows with the lingcod survey footrope and five tows with the shellfish survey footrope. The following day, the order in which the gear was used was reversed. All tows were made in the same direction. Minimal difference in tide height occurred during the sampling period on each day (0.9 m and 0.5 m respectively). Difference between densities from the two nets was tested using a nonparametric paired t-test.

RESULTS

We made a total of 71 tows at 18 sites in the Strait of Georgia between July 12–23, 2004. Eight of the 71 tows were designated as unusable when the net had to be retrieved early due to snagging on rocky bottom, or large quantities of kelp fouling the net. Eight sites were located in the northern region of the Strait of Georgia; seven were found in the south and three on the eastern side of the Strait (Figure 2). Tow position, depth, length, duration and other bridge log information are presented in Appendix Table 1.

The mean catch weight was 150 kg, with a minimum catch weight of 8 kg and maximum of 635 kg and total catch of (Appendix Table 1). 62 species of fishes were caught, as well as 50 taxa of invertebrates (identified to lowest taxonomic group possible) (Table 1). All catch data are presented in Appendix Tables 2 and 3. Length data are presented in Appendix Tables 4-6. Data will be archived in the Groundfish Biological database, GFBio, (Fisheries and Oceans Canada, Pacific Region, Groundfish Data Unit).

2004 Lingcod Data

We caught a total of 709 young-of-the-year lingcod and 11 age 1+ lingcod. As in previous surveys, the majority of the young-of-the-year lingcod (91%) were caught in the northern region. Only 61 young-of-the-year lingcod (9%) were caught in the southern region, despite comparable habitats and consistent gear and methodology. No young-of-the-year lingcod were caught in the eastern region; however, one year 1+ lingcod was caught at Wilson Creek. An additional 293 young-of-the-year lingcod were caught during the footrope calibration work.

Median Densities

Median density of lingcod varied between 0 and 1846 fish·km^{-2} in the south and between 0 and 6461 fish·km^{-2} in the North (Table 2). No young-of-the-year lingcod were caught on the eastern side of the Strait (Table 2). The rank mean density of lingcod was significantly higher in the northern region than in the south or east; but the southern and eastern regions were not significantly different (Table 2, Figure 3).

A significant difference in median density of young-of-the-year lingcod existed between depth strata in the north; therefore, depth strata were considered separately. Significantly greater catches occurred in the shallow (15-24 m) depth stratum. However, there was no difference between depth strata in the south (Table 2, Figure 3). Due to the major differences between regions, we separated the data by region for all other analyses. A significant difference in density was not observed among sampling sites in the north or south, in either depth stratum.

The highest median densities were encountered at Oyster Bay (4298.5 fish·km^{-2}) in the shallow stratum, and Cape Lazo (4422.5 fish·km^{-2}) in the deep stratum. High densities

were also observed in the shallow stratum of French Creek (6408 fish·km^{-2}); however, only one shallow tow could be made. The lowest median densities in the northern region occurred at Little River, a new, randomly chosen, site, and at Kitty Coleman. Some tows in the South had relatively high catches; however, these densities were not consistent.

Footrope Calibration

No significant difference between the two footropes was detected with a Wilcoxon paired t-test (Table 3). Despite our attempts to control for variability, variation was higher in the footrope calibration project (Coefficient of Variation lingcod survey footrope=44 %, shellfish survey footrope=64%) than during the trawl survey at Qualicum Beach (12%) (Table 2). The change in footrope for the 2004 young-of-the-year survey does not appear to have introduced a significant bias.

Inter-Annual Comparisons 1991, 2003, 2004

To reduce sampling variance, data from the northern and southern regions were analysed separately due to the difference in catch rates between regions during all three periods (Table 4). In addition, only sites sampled in all years were compared. Young-of-the-year lingcod density were significantly higher in 2003 and 2004 than in 1991 in the northern region (Table 4). Most of the northern sites show consistent trends over the years, with the exception of French Creek and Black Creek (Figure 3).

Low densities of juvenile lingcod were found in the south in all time periods and lingcod were absent from many tows in all years. Young-of-the-year lingcod density decreased significantly between 1991 and 2003 ($p=0.032$, $U=4.585$, $df=1$); however, no differences were detected when all three years were considered together (Table 4). Although densities in the south were still quite low and highly variable, a few large catches did occur in 2004. The frequency of tows in which no lingcod were caught can also be examined. In 1991, 10 of 21 (48%) sets in the south had no lingcod, 14 of 19 (74%) sets in 2003, and 11 of 21 (52%) sets in 2004 had no lingcod. Although no difference was detected between 2003 and 2004, lingcod were caught in a greater proportion of tows in 2004 than in 2003.

Biological Data

We measured the lengths and weights of 719 lingcod (Table 5) and calculated condition factors from these data ($CF=W/L^3 \times 10{,}000$) (Caillet *et al*, 1986). A length frequency histogram (Figure 4) suggests the presence of two year classes: young-of-the-year lingcod (n=708; length < 200 mm) and age 1+ lingcod (n=11; length > 240 mm). Descriptive statistics for length, weight, and condition factor for young-of-the-year and age 1+ lingcod by survey site and depth stratum in 2004 are given in Table 5.

Kruskal-Wallis tests revealed significant differences among lengths, weights and condition factor of lingcod among sites, and also among depth strata (Table 5). However, the Kruskal-Wallis test is known to be conservative (Zar 1999), and subsequent non-parametric Tukey-type multiple comparison tests did not reveal any significant differences between specific sites or depth strata for either length or weight ($p<0.001$) (Figures 5 and 6). Condition Factor at Nanaimo, Bowser and Qualicum was higher than at Oyster Bay or Black Creek. Condition factor was also greater in the third depth stratum (35-44 m) than in Depth Stratum 1 or 2. All lingcod caught in Nanaimo were caught in the deeper depth stratum (25-34 m).

Median and mean lengths for young-of-the-year lingcod for all sites and depth strata combined were 150.0 mm and 148.9 mm (SD=14.3), respectively, while median and mean weights were 22.0 g and 22.4 g (SD=9.5), respectively.

Inter-annual Comparison of Biological Data

Length, weight and condition factor are difficult to compare among years since the timing of each survey is offset by a couple of weeks. Young-of-the-year lingcod have rapid growth rates; therefore, small temporal changes may greatly affect comparisons (Beamish *et al.* 1978). The footrope calibration provided a second period later in the year to sample young-of-the-year lingcod. Although median length, weight and condition factor are all greater in August 2004 than July 2004 (Table 6), growth rates cannot be determined in absence of aging data. Condition factor of the August 2004 lingcod also seems to be higher than 2003 data (Table 6), but was not tested due to the confounding effects of growth over the season.

2004 Diet Analysis

From a total catch of 708 YOY lingcod, 410 stomachs were examined (Table 7). Of these, 127 (31%) were empty and 15 (4 %) contained unidentified remains. The contents of the remaining 268 (65%) stomachs were identified to a general category (e.g. fish remains) or to species. Of these, 70.0% contained fish remains as the primary food item.

We examined the difference in diet between depth strata and by fish size (100-150 mm and 151-200 mm in length) (Tables 8 and 9). Larger young-of-the-year lingcod eat a greater proportion of fish (as opposed to invertebrates) than smaller lingcod do. The proportion of fish in small to large lingcod stomachs was 65:90 in the shallow stratum and 48:72 in the deep stratum. Lingcod diet appears to be more closely related to the length attained by the lingcod than it is to the depth stratum it was caught in.

DISCUSSION

Distribution patterns of young-of-the-year lingcod in the Strait of Georgia were similar to patterns observed in past lingcod trawl surveys (Haggarty *et al.* 2003, Workman *et al.* 1992). Juvenile lingcod abundance is much higher in the north-western region of the Strait of Georgia than the south or east. Unfortunately, steeper, rockier shores on the eastern side of the Strait were mostly inaccessible to our trawl gear so this survey was not able to provide much additional information on the broader geographical distribution in the Strait of Georgia. Towed or remotely operated cameras would perhaps enable us to access these areas. The extensive sand/mud banks off the Fraser River may be valuable young-of-the-year lingcod habitat. Regretfully, we were not able to make any tows in this area due to the presence of commercial crab traps. No young-of-the-year lingcod were caught in the few successful tows we were able to make at Spanish Banks, in Burrard Inlet, or Wilson Creek, on the Sunshine Coast.

A new net was used in the 2004 survey due the poor condition of the old net. Although the dimensions were the same, a different material was used. This may affect the net's catchability since polypropylene is more buoyant than nylon; however, the two nets could not be compared because the old net was in extremely poor condition. In addition, a different footrope with larger rubber disks was used. The calibration experiment showed that the change in footrope did not introduce a significant bias; however, the power of this calibration was low due to the small sample size of tows with each net (n=10). The calibration work, was, however, only performed over sandy bottoms. The footrope with larger rubber disks may perform better on bottoms with mixed sand-rock substrates than the footrope with small disks. This was not quantified due to the limited time in which to complete the calibration work.

Young-of-the-year lingcod density was significantly higher in the northern region in 2003 and 2004 than in 1991. Two possible explanations for the observed increase between sampling years in the northern region are: 1) an increase in spawning stock biomass; 2) more favourable ocean conditions leading to increased survival of larval and post-larval lingcod. Both explanations are possible and may be working in concert. A hook and line survey of year 2+ lingcod (76% of which were mature or maturing) showed that the relative abundance of lingcod in the northern-most areas of the Strait of Georgia (Statistical Areas 13 and 15) increased between the mid-to late-1980's and 2004 (Haggarty and King in press). In addition to an increased spawning biomass, larval and post larval survival in 2003 and 2004 may be higher than it was in 1991. 1991 fell within an unfavourable ocean regime when growth and survival of young fishes and thus recruitment to fisheries was low (McFarlane *et al.* 2000). Conversely, environmental and biological data seem to indicate that another regime shift occurred in 1998 (King 2005; McFarlane *et al.* 2000); therefore, 2003 and 2004 young-of-the-year lingcod may be experiencing more favourable environmental conditions.

We did not detect a difference between 2003 and 2004 densities, although the median and mean 2004 density of young-of-the-year lingcod appear to be slightly lower in the north and slightly higher in the south. High variability in catch rates among sites, particularly in

the southern region, may have made it difficult to detect significant small differences in density (i.e. difference between 2003 and 2004 surveys). In order to minimize between site variability, we did not include the muddy sites since this habitat had catch rates with high variability during the 1991 survey and it appears not to be a preferred habitat for young-of-the-year lingcod (Haggarty *et al.* 2004, Workman *et al.* 1992). Additional efforts to reduce sources of variability should be explored. Surveying each site with a towed camera may refine habitat classification and help to explain some of the high variability encountered in this, and many trawl surveys.

Two years of length and weight data are now available for young-of-the-year lingcod. Condition factor does vary between sampling sites and may also vary between years, although the effect of growth over the season renders comparisons difficult. Relationships between growth, condition factor and density dependence may be interesting to explore with young-of-the-year lingcod.

The young-of-the-year lingcod trawl survey provides an estimate of lingcod year-class strength. The 2004 lingcod year class in the northern Strait of Georgia appears to be stronger than it was in 1991, but comparable to 2003. The 2004 southern Strait of Georgia year class, although not significantly different from either 1991 or 2003, may be slightly stronger than it was in 2003.

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REFERENCES

Beamish, R.J., Weir, J.R., Scarsbrook, J.R., and Smith, M.S. 1978. Growth of young Pacific hake, walleye pollock, Pacific cod and lingcod in Stuart Channel in 1976. Fish. Res. Board Man. Rep. Ser. 1518.

Cailliet, G.M., Love, M., and Ebeling, A.W. 1986. Fishes: a field and laboratory manual on their structure, identification and natural history. Waveland Press, Prospect Heights, Illinois.

Cass, A.J., Beamish, R.J., and McFarlane, G.A. 1990. Lingcod (*Ophiodon elongatus*). Can. Spec. Pub. Fish. Aquat. Sci. 109: 40.

Forrester, C.R., and Smith, J.E. 1974. The Trawl Fishery in the Strait of Georgia and Vicinity, 1960-72. Circular, 96, Fisheries Research Board of Canada, Nanaimo.

Haggarty, D.R., and King, J.R. 2005. Hook and line survey of Lingcod (*Ophiodon elongatus*) and Rockfish (*Sebastes spp.*) in northern Strait of Georgia (statistical areas 13, 14, 15 and 16) June 14-July 9, 2004. Can. Tech. Rep. Fish. Aquat. Sci. 2590: 57p.

Haggarty, D.R., King, J.R., and Mathias, K.L. 2004. Bottom trawl survey of young-of-the year lingcod (*Ophiodon elongatus)* in the strait of Georgia by the *R/V Neocaligus,* July 28 - August 9, 2003. Can. Manuscr. Rep. Fish. Aquat. Sci. 2673: 39 p.

King, J.R. (Ed.). 2005. Report of the Study Group on Fisheries and Ecosystem Responses to Recent Regime Shifts. PICES Sci. Rep. No. 28. 162 p.

King, J.R. 2001. Assessment of Lingcod in the Strait of Georgia. Can. Sci. Ad. Sec. Res. Doc. 2001/132.

King, J.R., and Surry, A.M. 2000. Lingcod Stock Assessment and Recommended Yield Options for 2001. Can. St. Assess. Sec. Res. Doc., 2000/164.

King, J.R., McFarlane, G.A., and Surry, A.M. 2003. Stock assessment framework for Strait of Georgia lingcod. Can. Sci. Ad. Sec. Res. Doc. 2003/04.

Low, C.J., and Beamish, R.J. 1978. A study of the nesting behaviour of lingcod (*Ophidion elongatus*) in the Strait of Georgia British Columbia. Fisheries and Marine Service Technical Report, 843, Fisheries and Oceans Canada, Ottawa.

McFarlane, G.A., King, J.R., and Beamish, R.J. 2000. Have there been recent changes in climate? Ask the fish. Prog. Oceanogr. **47**: 147-169.

Phillips, A.C., and Barraclough, W.E. 1977. On the early life history of the Lingcod (*Ophiodon elongatus*). Fish. Mar. Serv. Tech. Rep. 756.

Richards, L.J., and Hand, C.M. 1989. Lingcod. pp. 35-61. In Groundfish Stock Assessment for the West Coast of Canada in 1988 and Recommended Yield Options for 1989. J. Fargo and A.V. Tyler [eds.]. Can. Tech. Rep. Fish. Aquat. Sci. 1646:294 p.

Wilby, G.V. 1937. The Lingcod, *Ophiodon elongatus* girard. Bull. Fish. Res. Board Can., 54.

Workman, G.D., Yamanaka, L.J., and Richards, L.J. 1992. Bottom trawl survey of young-of-the-year Lingcod (*Ophiodon elongatus*) in the Strait of Georgia by *R/V Caligus*, June [sic] 15 - August 3, 1991. Can. Man. Rep. Fish. Aquat. Sci. 2167.

Zar, J.H. 1999. Biostatistical Analysis. 4th ed. Prentice Hall, Inc., New Jersey. 663 p.

Table 1. Common and taxonomic names of fish and invertebrate species caught in the 2004 bottom trawl survey of young-of-the-year lingcod, *CCGS NEOCALIGUS*, July 13 – 26, 2004. The catch weight (kg) and the percent (rounded to the nearest 0.0 %) of the total catch of the survey is presented for each species.

Common Name	Scientific Name	Weight (kg)	% of Total Catch
Fish			
Spiny dogfish	*Squalus acanthias*	2499.1	26.2
Rock sole	*Pleuronectes bilineatus*	2496.8	26.2
English sole	*Pleuronectes vetulus*	2042.2	21.4
Starry flounder	*Platichthys stellatus*	576.7	6.0
Blackbelly eelpout	*Lycodes pacificus*	201.8	2.1
Pacific sanddab	*Citharichthys sordidus*	167.6	1.8
Spotted ratfish	*Hydrolagus colliei*	156.0	1.6
Plainfin midshipman	*Porichthys notatus*	72.3	0.8
Flathead sole	*Hippoglossoides elassodon*	71.4	0.7
Shiner perch	*Cymatogaster aggregata*	64.1	0.7
Pacific cod	*Gadus macrocephalus*	56.3	0.6
C-o sole	*Pleuronichthys coenosus*	47.5	0.5
Speckled sanddab	*Citharichthys stigmaeus*	45.8	0.5
Pacific tomcod	*Microgadus proximus*	44.9	0.5
Snake prickleback	*Lumpenus sagitta*	43.1	0.5
Cabezon	*Scorpaenichthys marmoratus*	41.8	0.4
Sand sole	*Psettichthys melanostictus*	28.4	0.3
Slender sole	*Eopsetta exilis*	27.5	0.3
Walleye pollock	*Theragra chalcogramma*	25.7	0.3
Roughback sculpin	*Chitonotus pugetensis*	22.8	0.2
Lingcod	*Ophiodon elongatus*	20.1	0.2
Big skate	*Raja binoculata*	19.8	0.2
Great sculpin	*Myoxocephalus polyacanthocephalus*	14.0	0.1
Whitespotted greenling	*Hexagrammos stelleri*	12.8	0.1
Rex sole	*Errex zachirus*	12.1	0.1
Longnose skate	*Raja rhina*	12.1	0.1
Pacific herring	*Clupea pallasi*	11.6	0.1
Pacific staghorn sculpin	*Leptocottus armatus*	10.9	0.1
Quillback rockfish	*Sebastes maliger*	10.7	0.1
Copper rockfish	*Sebastes caurinus*	7.7	0.1
Dover sole	*Microstomus pacificus*	6.4	0.1
Longspine combfish	*Zaniolepis latipinnis*	5.8	0.1
Sturgeon poacher	*Podathecus acipenserinus*	4.3	0.0
Threadfin sculpin	*Icelinus filamentosus*	3.7	0.0
Pacific hake	*Merluccius productus*	2.4	0.0
Butter sole	*Pleuronectes isolepis*	1.5	0.0
Striped seaperch	*Embiotoca lateralis*	1.5	0.0
Kelp greenling	*Hexagrammos decagrammus*	1.3	0.0
Longfin smelt	*Spirinchus thaleichthys*	1.3	0.0
Tube snouts	*Aulorhynchus flavidus*	1.1	0.0
Ribbed sculpin	*Triglops pingeli*	1.0	0.0
Slim sculpin	*Radulinus asprellus*	0.9	0.0

Table 1. (Cont.)

Common Name	Scientific Name	Weight (kg)	% of Total Catch
Fish (Cont.)			
Buffalo sculpin	*Enophrys bison*	0.8	0.0
Northern spearnose poacher	*Agonopsis vulsa*	0.7	0.0
Sailfin sculpin	*Nautichthys oculofasciatus*	0.6	0.0
Grunt sculpin	*Rhamphocottus richardsoni*	0.5	0.0
Snailfishes	*Liparinae*	0.3	0.0
Decorated warbonnet	*Chirolophis decoratus*	0.2	0.0
Pacific sandfish	*Trichodon trichodon*	0.2	0.0
Padded sculpin	*Artedius fenestralis*	0.2	0.0
Spotfin sculpin	*Icelinus tenuis*	0.2	0.0
Northern ronquil	*Ronquilus jordani*	0.1	0.0
Whitebarred prickleback	*Poroclinus rothrocki*	0.1	0.0
Longfin gunnel	*Pholis clemensi*	0.1	0.0
Saddleback gunnel	*Pholis ornata*	0.1	0.0
Dwarf wrymouths	*Cryptacanthodes aleutensis*	0.1	0.0
Bay goby	*Lepidogobius lepidus*	0.1	0.0
Greenstriped rockfish	*Sebastes elongatus*	0.1	0.0
Spinyhead sculpin	*Dasycottus setiger*	0.1	0.0
Northern sculpin	*Icelinus borealis*	0.1	0.0
Blacktip poacher	*Xeneretmus latifrons*	0.1	0.0
Pacific spiny lumpsucker	*Eumicrotremus orbis*	0.1	0.0
	Total for fish	8899.6	93.3
Invertebrates			
Plumose anemone	Metridium	249.5	2.6
Dungeness crab	*Cancer magister*	117.4	1.2
Sunflower starfish	*Pycnopodia helianthoides*	54.8	0.6
Pink short-spined star	*Pisaster brevispinus*	52.1	0.5
Jellyfish	Scyphozoa	47.7	0.5
Coonstripe shrimp	*Pandalus danae*	34.4	0.4
Scallop	Pectinidae	25.9	0.3
Cancer gracilis	*Cancer gracilis*	22.1	0.2
Red urchin	*Strongylocentrotus franciscanus*	6.3	0.1
Glass sponges	Hexactinellida	4.7	<0.1
Sea cucumber	Holothuroidea	2.9	<0.1
Oregontriton	*Fusitriton oregonensis*	2.7	<0.1
Sand star	*Luidia foliolata*	2.3	<0.1
Red rock crab	*Cancer productus*	2.2	<0.1
Nudibranchs	Nudibranchiata	2.2	<0.1
Mottled star	*Evasterias trochelii*	2.1	<0.1
Sea pen	*Ptilosarcus gurneyi*	1.6	<0.1
Pacific geoduck	*Panopea abrupta*	1.6	<0.1
Vermillion starfish	*Mediaster aequalis*	1.5	<0.1
Kelp crab	*Pugettia producta*	1.4	<0.1
Butter clam	*Saxidomus gigantea*	0.9	<0.1

Common Name	Scientific Name	Weight (kg)	% of Total Catch
Invertebrates (Cont.)			
Ascidians and tunicates	Ascidiacea	0.8	<0.1
Prawn	*Pandalus platyceros*	0.8	<0.1
Opalescent inshore squid	*Loligo opalescens*	0.5	<0.1
Spike shrimp (horned shrimp)	*Paracrangon echinata*	0.5	<0.1
Tanner crabs	Chionoecetes	0.4	<0.1
Polychaete worms (Nereis)	Polychaeta	0.3	<0.1
Hermit crabs	Paguridae	0.4	<0.1
Spider crabs	Oxyrhyncha	0.3	<0.1
Brittle stars	Ophiurae	0.2	<0.1
Nutclams	Nuculidae	0.2	<0.1
Green urchin	*Strongylocentrotus droebachiensis*	0.2	<0.1
Pale sea cucumber	*Cucumaria pallida*	0.2	<0.1
Pacific red octopus	*Octopus rubescens*	0.2	<0.1
Pandalid shrimp	Pandalus	0.2	<0.1
Box crabs	Lopholithodes	0.2	<0.1
Leather star	*Dermasterias imbricata*	0.2	<0.1
Lewismoon snail	*Polinices lewisii*	0.1	<0.1
Rock snails	Muricidae	0.1	<0.1
Anemone	Actiniaria	0.1	<0.1
Flatworms	Flatworms	0.1	<0.1
Morning sun starfish	*Solaster dawsoni*	0.1	<0.1
Striped sun starfish	*Solaster stimpsoni*	0.1	<0.1
Rose starfish	*Crossaster papposus*	0.1	<0.1
Doridídae (nudibranch)	Doridídae	0.1	<0.1
Arminidae (nudibranch)	Arminidae	0.1	<0.1
Peppered sea cucumber	*Cucumaria piperata*	0.1	<0.1
Pacific razor	*Siliqua patula*	0.1	<0.1
Macoma	Macoma	0.1	<0.1
Pacific bobtail squid	*Rossia pacifica*	0.1	<0.1
	Total for invertebrates	643.2	6.7
	Total for all species	9542.8	100

Table 2. Young-of-the-year lingcod density (fish·km^{-2}) data per site and region by depth stratum in the Strait of Georgia, July 13 – 26, 2004 survey on the *CCGS Neocaligus*. The number of tows made (N), along with the density range, median and mean density (with standard deviation (SD) and coefficient of variation (CV)) are provided for each site, and are summarized by region and by depth strata. Kruskal-Wallis test statistics for differences in lingcod density are presented for comparison between sites within depth strata and for comparison between depth strata within a region. Overall, there were significant differences between lingcod densities among the regions for both the shallow depth strata (H=20.7, p<0.0001, df=2) and the deep depth strata (H=14.3, p=0.0008, df=2).

		Depth Stratum 1 (15-24 m)						Depth Stratum 2 (25-34 m)					
Statistical Area	Site	N	Range	Median	Mean	SD	CV	N	Range	Median	Mean	SD	CV
Northern Region													
13	Oyster Bay	2	2136-6461	4298.5	4298.5	3058.2	71	2	1038-1899	1468.5	1468.5	608.8	41
14	Black Creek	2	1187-1925	1556.0	1556.0	521.8	34	2	773-1466	1119.5	1119.5	490.0	44
14	Kitty Coleman	2	1896-4367	3131.5	3131.5	1747.3	56	1	0				
14	Little River	1	727					1	213				
14	Cape Lazo	2	1312-2517	1914.5	1914.5	852.0	45	2	4052-4793	4422.5	4422.5	524.0	12
14	Comox	2	2130-3039	2584.5	2584.5	642.8	25	2	0-909	454.5	454.5	642.8	141
14	Bowser	2	580-1385	982.5	982.5	569.2	58	2	1063-1303	1183.0	1183.0	169.7	14
14	Qualicum	2	2243-2663	2453.0	2453.0	297.0	12	2	649-765	707.0	707.0	82.0	12
14	French Creek	1	6408					2	1350-2738	2044.0	2044.0	981.5	48
		(Difference among sites: H=10.1, p=0.259, df=8)						(Difference among sites: H=12.7, p=0.1229, df=8)					
		(Difference among depth strata: H=5.1, p=0.0237, df=1)											
	All sites	16	580-6461	2133.1	2560.9	1769.2	69	16	0-4793	1050.5	1438.1	1360.1	95
Southern Region													
17	Nanoose	2	189-483	335.9	335.9	208.0	62	3	189-923	193	435.0	422.6	97
17	Nanaimo	0						1	0	0	0		
17	Pylades	1	561					1		791.1	791.1		
17	Kuper	3	0					1		0	0		
17	Walker Hook	2	0-90	45.1	45.1	63.8	141	1		0	0		
18	Fulford Hrb	2	0					1		0	0		
19	Sidney	1	1846					1		0	0		
		(Difference among sites: H=9.3, p=0.0983, df=5)						(Difference among sites: H=7.25, p=0.2981, df=6)					
	All sites	11	0-1846	0	288.1	555.6	193	9	0-923	0	232.9	364.5	156
		(Difference among depth strata: H=.007, p=0.9337, df=1)											
Eastern Region													
20	Spanish Banks	2	0					2	0				
21	Wilson Creek	1	0					2	0				
22	Thormanby	0	0					1	0				
	All sites	3	0					5	0				

Table 3. Density (fish·km^{-2}) of young-of-the-year lingcod captured using the lingcod survey footrope and shellfish survey footrope during the calibration experiment aboard the *CCGS Neocaligus* at Qualicum Beach, August 22-23, 2004. Trawl sites (1-10) were paired along parellel transects at depths between 22-27 m. There was no significant difference in lingcod densities between the lingcod survey footrope and the shellfish survey footrope (Wilcoxon paired t-test: T=-1.50, p=0.169, df=9). Mean (standard devation=SD; coefficient of variation=CV), median and the range of lingcod densities observed with the lingcod survey footrope and the shellfish survey footrope are also presented.

Paired trawl site	Lingcod survey footrope	Shellfish survey footrope
1	2753.7	3374.7
2	860.2	2205.4
3	710.0	4699.7
4	1796.1	1044.9
5	1656.7	1166.7
6	1432.2	1496.8
7	1602.2	2152.7
8	1122.6	1083.5
9	653.1	1077.3
10	2040.7	2588.9
Mean	1462.8	2089.1
SD	655.81	1204.7
CV	45	58
Median	1517.2	1824.7
Range	653-2754	1045-4700

Table 4. Young-of-the-year lingcod density statistics for the northern region and the southern region for surveys conducted in 1991, 2003 and 2004 in the Strait of Georgia. Kruskal-Wallis test statistics for differences in lingcod density are presented for comparison between years within a region as well as between regions. A significant difference exist for lingcod density between the Northern and Southern region for each year as well as a significant difference between 1991 and 2003-2004 in the North. Only sites sampled in all three years were included in this analysis.

	North					South				
	N	Mean	SD	Med	Range	N	Mean	SD	Med	Range
1991	19	1694.4	2564.7	770.0	122–11111	17	547.6	895.4	187.0	0–3376
Difference between regions: U=8.7, **p=0.0033**, df=1										
2003	23	2673.3	2302.2	1881.0	293–9839	19	124.6	286.9	0.0	0–1182
Difference between regions: U=29.7, **p<0.0001**, df=1										
2004	18	1861.3	1306.9	1348.0	0–4792	21	334.0	559.7	0	0–1846
Difference between regions: U=17.8, **p<0.0001**, df=1										
Difference among years by region:										
H=8.5, **p=0.0144**, df=2						H=4.3, p=0.1168, df=2				

Table 5. Number of fish sampled (N), median and mean (standard deviation=SD; coefficient of variation=DV) for length, weight, and condition factor for young-of-the-year lingcod captured in the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004 for sites and depth strata. Kruskal-Wallis test statistics for differences in length, weight and condition factor between sites and between depth strata are in parentheses.

		N	Length (mm)				Weight (g)				Condition Factor (x 10^{-5})			
			Median	Mean	SD	CV	Median	Mean	SD	CV	Median	Mean	SD	CV
Site	Code													
Black Creek	BC	50	153.5	151.8	14.4	9.5	21.0	22.6	7.6	33.8	0.61	0.62	0.08	12.6
Bowser	BW	46	145.0	146.4	11.1	7.6	22.0	22.2	6.5	29.4	0.70	0.69	0.09	13.2
Cape Lazo	CL	117	152.0	150.7	11.6	7.7	22.0	22.4	5.9	26.3	0.63	0.64	0.06	10.0
Comox	CX	57	140.0	140.7	10.7	7.6	18.0	18.1	4.8	26.4	0.63	0.64	0.06	9.4
French Creek	FC	96	148.0	148.3	16.1	10.8	20.5	22.2	9.6	43.1	0.63	0.65	0.07	11.2
Kitty Coleman	KC	64	151.5	150.7	12.4	8.2	22.0	24.0	7.6	31.6	0.67	0.68	0.08	12.1
Little River	LR	9	150.0	146.3	8.5	5.8	19.0	19.8	4.4	22.3	0.62	0.62	0.04	6.8
Nanaimo	NM	18	173.5	173.1	10.8	6.3	37.0	36.6	8.6	23.5	0.70	0.69	0.06	8.2
Nanoose	NS	19	151.0	148.6	14.9	10.0	22.0	22.2	8.1	36.5	0.63	0.64	0.10	15.6
Oyster Bay	OB	99	152.0	150.2	10.4	7.0	22.0	22.0	5.4	24.4	0.63	0.64	0.07	10.5
Pylades Ch.	KP	11	155.0	157.6	12.2	7.8	25.0	26.9	8.6	31.9	0.65	0.67	0.08	12.7
Qualicum	QU	105	150.0	146.2	17.5	11.9	22.0	21.5	8.4	39.2	0.65	0.65	0.07	11.2
Sidney	SD	16	135.0	136.3	8.7	6.3	15.0	15.7	3.2	20.5	0.61	0.61	0.04	6.3
Walker Hook	WH	1	154.0	154.0	--	--	24.0	24.0	--	--	0.66	0.66	--	--
	Total	708	150.0	148.9	14.3	9.6	22.0	22.4	9.5	42.4	0.64	0.65	0.12	18.1
			(H = 92.22, df = 13, p < 0.001)				(H = 80.86, df = 13, p < 0.001)				(H = 41.9, df = 13, p < 0.001)			
Depth stratrum														
Stratum 1 (15-24 m)		412	147	145.5	14.1	9.7	20	20.7	7.2	34.7	0.64	0.65	0.08	12.3
Stratum 2 (25-34 m)		239	153	152.1	12.1	8.0	22	23.3	7.3	31.4	0.63	0.64	0.07	10.9
Stratum 3 (35-44 m)		57	160	159.7	15.3	9.6	27	28.5	9.0	31.8	0.67	0.67	0.06	9.0
			(H = 62.84, df = 2, p < 0.001)				(H = 54.83, df = 2, p < 0.001)				(H = 13.6, df = 2, p< 0.001)			

Table 6. Descriptive statistics (number of fish (N), range, median and mean (standard deviation (SD) and coefficient of variation (CV)) for length (mm), weight (g), and Condition Factor (CF) of young-of-the-year lingcod in the Strait of Georgia in 2003 and 2004, and for length in 1991 (weight not measured). Dates for the surveys are as follows: 2004, July 12-23 and August 22-23 (footrope calibration); 2003, July 28-August 9; 1991, July 15-August 3.

	Year	N	Range	Median	Mean	SD	CV
Length	1991	501	104–192	145.0	144.9	16.3	11.2
	2003	645	106–199	160.0	158.9	13.5	8.5
	2004 -July	651	103–150	150.0	147.9	13.8	9.3
	2004 -August	293	105–200	152.0	153.2	16.6	10.8
Weight	2003	633	6–56	26.0	25.9	7.2	27.8
	2004-July	651	6–59	21.0	21.7	7.3	33.8
	2004-August	293	6–56	25.0	26.1	9.25	35.5
CF ($\times 10^{-5}$)	2003*	633	0.4–1.1	0.63	0.60	0.07	11.5
	2004-July	651	0.3–1.0	0.64	0.65	0.07	11.6
	2004-August	293	0.5–1.0	0.70	0.70	0.07	10.6

*Please note that erroneous CF values were reported for 2003 in Haggarty *et al.* (2004). Corrected CF figures are reported here.

Table 7. Summary information for stomach contents analysis of young-of the-year lingcod caught in the 2004 bottom trawl survey in the Strait of Georgia, July 13-29, 2004. Data are presented by depth stratum (shallow=15-24 m; deep=25-34 m) and by lingcod length (100-150 mm; 151-200 mm). Lingcod caught in the deeper depth stratum (35-44 m) were omitted for this analysis.

	Combined depth strata			Shallow stratum		Deep stratum	
	All lengths	100-150 mm	151-200 mm	100-150 mm	151-200 mm	100-150 mm	151-200 mm
Number of lingcod caught	651	351	300	247	165	104	135
Number of stomachs examined	374	194	180	148	100	46	80
Number of stomachs with prey items	261	143	118	112	73	31	45
Number of stomachs with identifiable items	248	137	111	107	66	30	45
Number of stomachs with 1 prey item	240	131	109	102	65	29	44
Number of stomachs with 2 prey items	8	6	2	5	1	1	1
Mean (SD) volume (cc) in stomachs examined	2.06 (2.16)	1.71 (1.66)	2.48 (2.59)	1.62 (1.57)	2.76 (2.91)	2.03 (1.93)	2.02 (1.89)
Mean (SD) length (mm) of fish examined	148.71 (14.52)	137.76 (9.83)	160.52 (8.04)	136.30 (10.27)	159.66 (7.18)	142.46 (6.38)	161.59 (8.94)
Mean (SD) weight (g) of fish examined	22.28 (7.98)	16.83 (4.35)	28.15 (6.74)	16.24 (4.29)	27.81 (6.21)	18.72 (4.03)	28.58 (7.36)
Mean (SD) condition factor of fish examined	0.65 (0.08)	0.63 (0.08)	0.67 (0.08)	0.63 (0.07)	0.67 (0.08)	0.64 (0.09)	0.67 (0.07)

Table 8. Prey items identified in the stomach contents from young-of-the-year lingcod caught in the shallow depth stratum (15-24 m) in the 2004 bottom trawl survey in the Strait of Georgia, July 13-29, 2004. All empty stomachs and stomachs with unidentifiable contents were removed from the analyses. N is the number of occurrences of each prey type, % of Volume is the proportion of total prey volume accounted for by each prey type, and % of Contents is the average proportion of individual volume of stomach contents accounted for by each prey type.

Prey Item	Small lingcod (100-150 mm)						Large lingcod (151-200 mm)					
	N	Frequency Occurrence (%)	Mean Volume (cm^3)	SD of Volume	% of Volume	% of Contents	N	Frequency Occurrence (%)	Mean Volume (cm^3)	SD of Volume	% of Volume	% of Contents
Fish prey												
Fish remains	51	47.7	1.3	0.9	35.9	96.4	36	54.5	1.8	1.8	32.3	99.1
Pacific herring	5	4.7	5.8	2.6	16.3	100.0	9	13.6	6.8	3.9	30.8	100.0
Pacific sandlance	3	2.8	3.3	1.2	5.6	100.0	6	9.1	4.2	3.0	12.6	100.0
Snake prickleback	4	3.7	2.0	0.0	4.5	86.7	2	3.0	2.5	0.7	2.5	100.0
Poachers	5	4.7	1.9	1.5	5.3	93.3	2	3.0	2.0	1.4	2.0	100.0
Sculpin	2	1.9	4.5	0.7	5.0	100.0	1	1.5	3.0	n/a	1.5	100.0
Walleye pollock	0	0.0					0	0.0				
Tubesnout	2	1.9	3.5	0.7	3.9	100.0	1	1.5	3.0	n/a	1.5	100.0
Pacific cod	0	--	--	--	--	--	2	3.0	9.0	1.4	9.1	100.0
Pacific tomcod	0	--	--	--	--	--	1	1.5	4.0	n/a	2.0	100.0
Flatfish	1	0.9	1.0	n/a	0.6	100.0	0	0.0				
Invertebrate prey												
Shrimp	17	15.9	1.7	1.4	16.0	90.4	2	3.0	4.0	1.4	4.0	100.0
Invertebrate remains	11	10.3	0.5	0.3	3.0	100.0	2	3.0	0.6	0.6	0.6	100.0
Euphausid/mysid	5	4.7	0.5	0.0	1.4	86.7	2	3.0	0.8	0.4	0.8	66.7
Amphipod	5	4.7	0.7	0.3	2.0	100.0	1	1.5	0.5	n/a	0.3	100.0
wood/algae	1	0.9	1.0	n/a	0.6	100.0	0	0.0				

Table 9. Prey items identified in the stomach contents from young-of-the-year lingcod caught in the deep depth stratum (25-34 m) in the 2004 bottom trawl survey in the Strait of Georgia, July 13-29, 2004. All empty stomachs and stomachs with unidentifiable contents were removed from the analyses. N is the number of occurrences of each prey type, % of Volume is the proportion of total prey volume accounted for by each prey type, and % of Contents is the average proportion of individual volume of stomach contents accounted for by each prey type.

	Small lingcod (100-150 mm)						Large lingcod (151-200 mm)					
Prey Item	N	Frequency Occurrence (%)	Mean Volume (cm^3)	SD of Volume	% of Volume	% of Contents	N	Frequency Occurrence (%)	Mean Volume (cm^3)	SD of Volume	% of Volume	% of Contents
Fish prey												
Fish remains	10	33.3	2.9	2.1	46.9	95.0	26	57.8	1.7	1.7	49.8	98.7
Pacific herring	2	6.7	5.0	0.0	16.2	100.0	1	2.2	5.0	n/a	5.5	100.0
Pacific sandlance	1	3.3	2.0	n/a	3.2	100.0	4	8.9	4.0	1.8	18.1	100.0
Snake prickleback	0	--	--	--	--	--	1	2.2	5.0	n/a	5.5	100.0
Sculpin	0	--	--	--	--	--	1	2.2	5.0	n/a	5.5	100.0
Walleye pollock	2	6.7	5.0	0.0	16.2	100.0	0	0.0				
Invertebrate prey												
Shrimp	5	16.7	1.0	0.0	8.1	100.0	2	4.4	3.5	2.1	7.7	100.0
Invertebrate remains	4	13.3	0.6	0.3	4.1	87.5	5	11.1	0.4	0.4	2.4	100.0
Euphausid/mysid	7	23.3	0.5	0.3	5.3	100.0	5	11.1	1.0	0.6	5.5	86.7
wood/algae	0	--	--	--	--	--	1	2.2	0.5	n/a	0.6	100.0

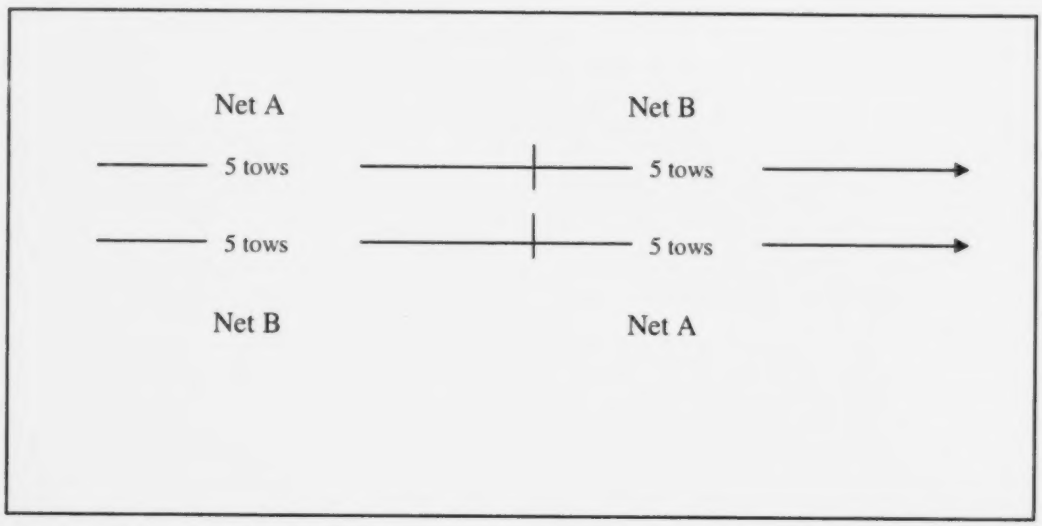

Figure 1. Diagram depicting the parallel transects that were used in the footrope calibration. Tows were made from south to north on August 22 and 23, 2004, off of Qualicum Beach, Vancouver Island, BC.

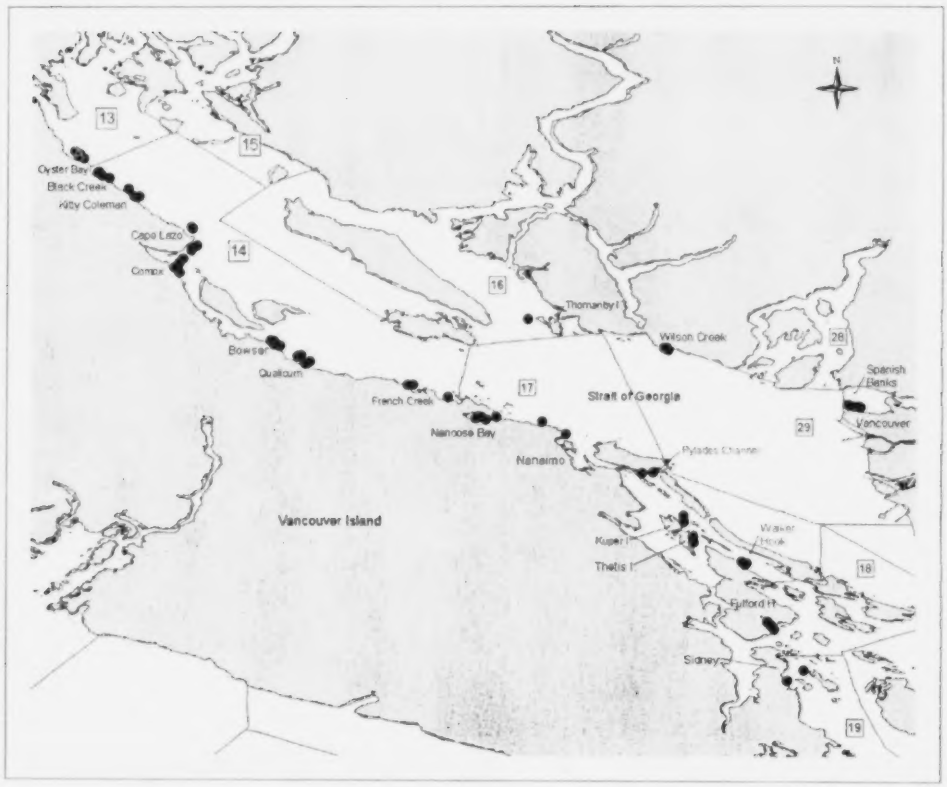

Figure 2. Trawl site locations and corresponding statistical areas in the Strait of Georgia for the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004. Statistical areas (numbers in boxes) 13 and 14 are in the northern Strait of Georgia; Statistical Areas 17, 18 and 19 are in the southern region, and Statistical Areas 15, 16, 28 and 29 are in the Eastern Strait of Georgia.

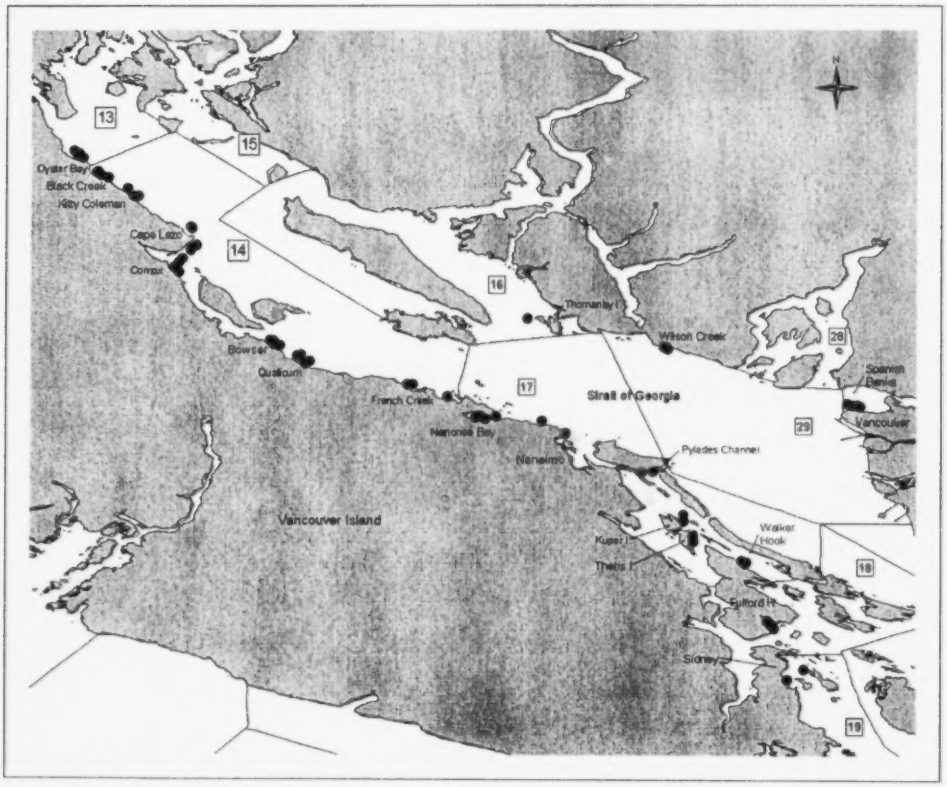

Figure 2. Trawl site locations and corresponding statistical areas in the Strait of Georgia for the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus,* July 13 – 26, 2004. Statistical areas (numbers in boxes) 13 and 14 are in the northern Strait of Georgia; Statistical Areas 17, 18 and 19 are in the southern region, and Statistical Areas 15, 16, 28 and 29 are in the Eastern Strait of Georgia.

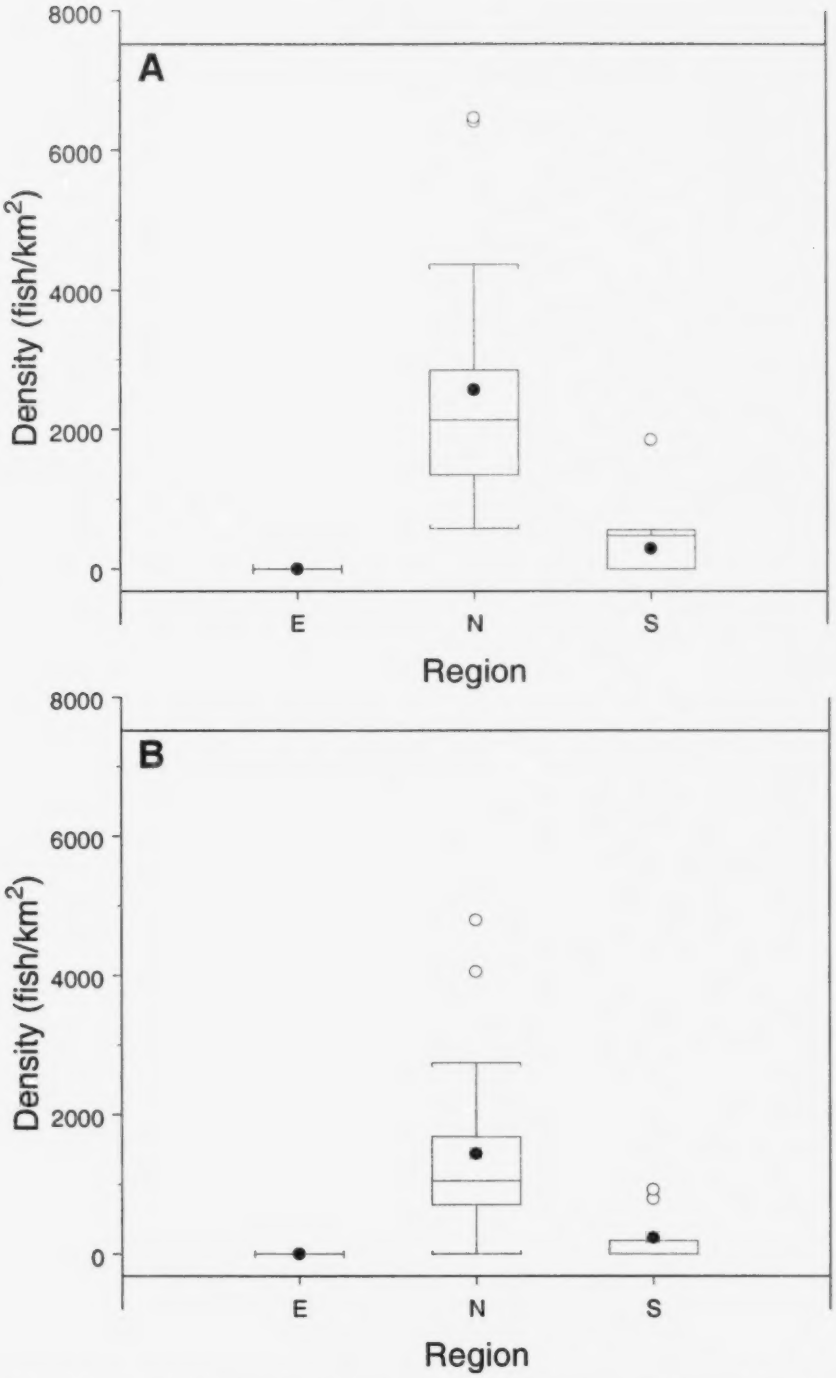

Figure 3. Box plots representing the density (fish/km^2) of young-of-the-year lingcod by region (N=North, S=South, E=East) during the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004. A= Depth Stratum 1 (15-24 m), B= Depth Stratum 2 (25-34 m). The horizontal line in the centre of each box represents the median, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers while outliers are represented by ○. The mean lengths are represented by ●.

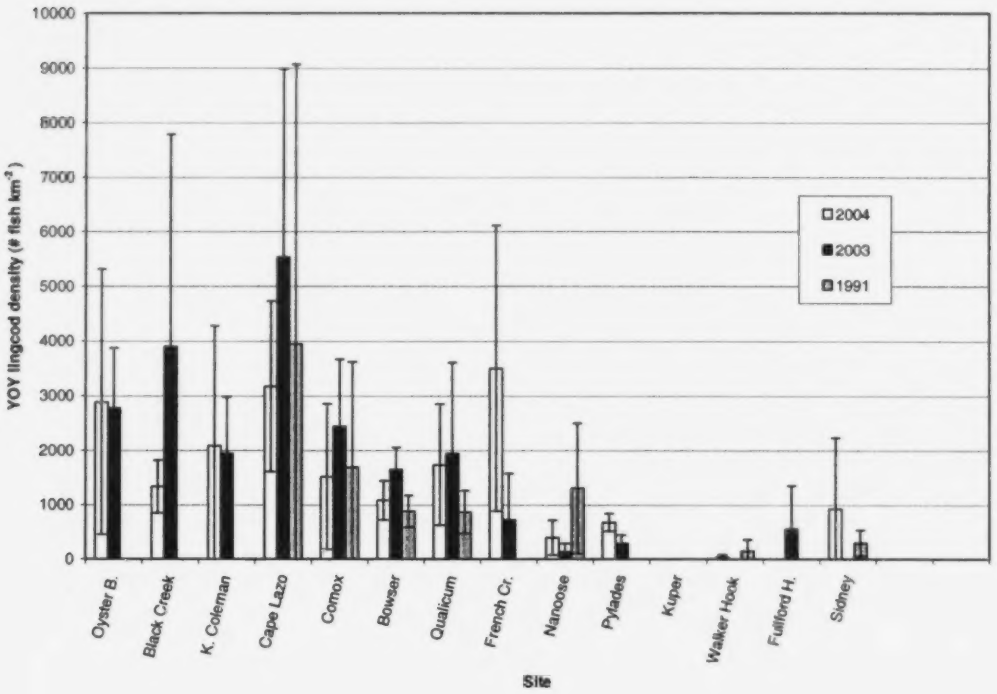

Figure 4. Comparison of mean density (fish·km^{-2}) of young-of-the-year lingcod in the Strait of Georgia by site and sampling years. Error bars represent standard deviation. Not all sites were sampled in all years.

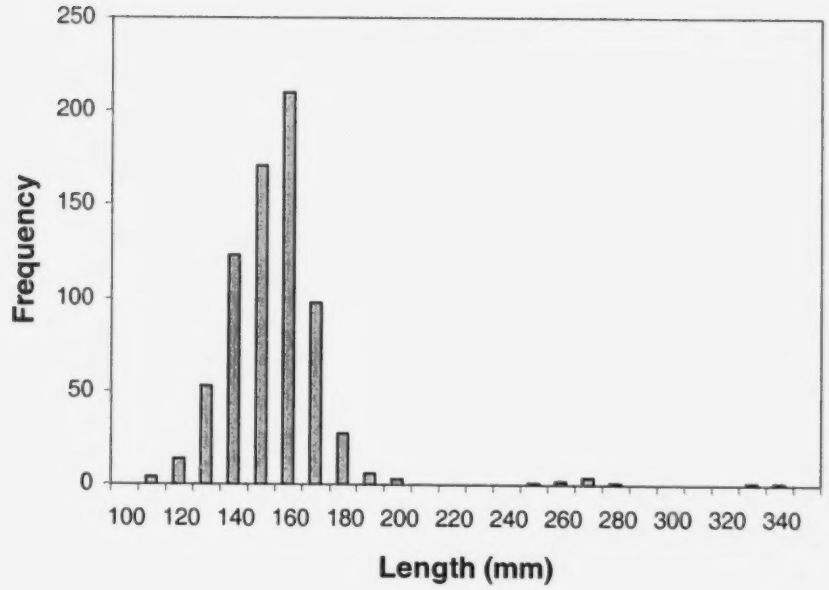

Figure 5. Frequency (numbers of fish) by 10 mm length intervals for young-of-the-year (n=708) and year 1+ lingcod (n=11) captured during the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004. Length intervals begin with number indicated for category.

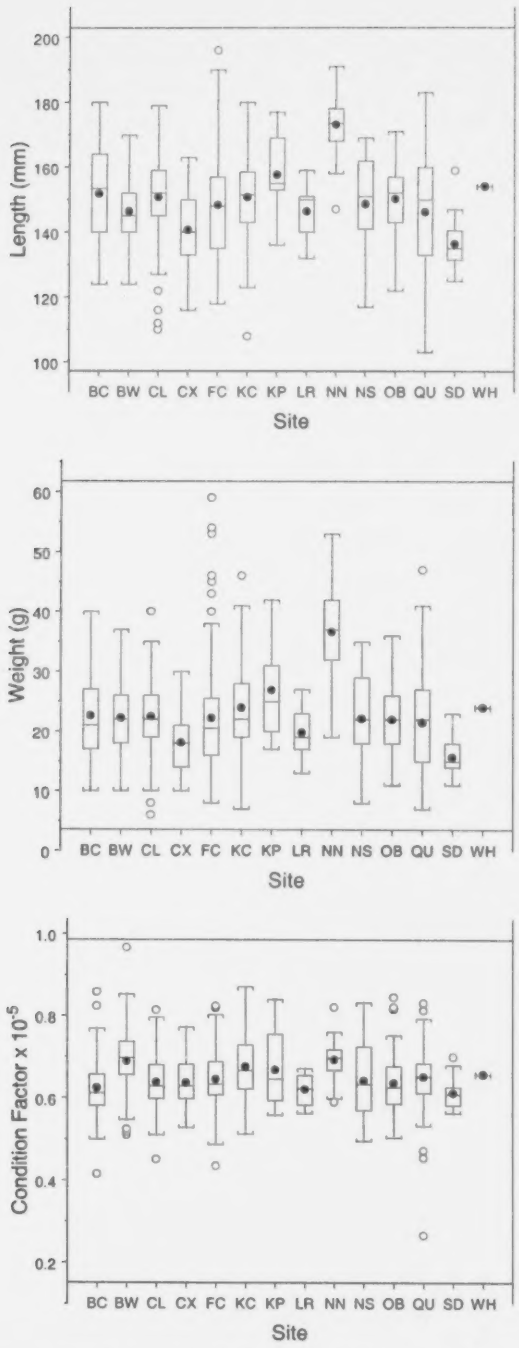

Figure 6. Box plots representing length (mm), weight (g), and Condition Factor distribution of young-of-the-year lingcod by sampling site for lingcod captured during the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus,* July 13 – 26, 2004. The horizontal line in the centre of each box represents the median, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers while outliers are represented by ○. The mean lengths are represented by ●. See Table 5 for sampling site codes and sample sizes.

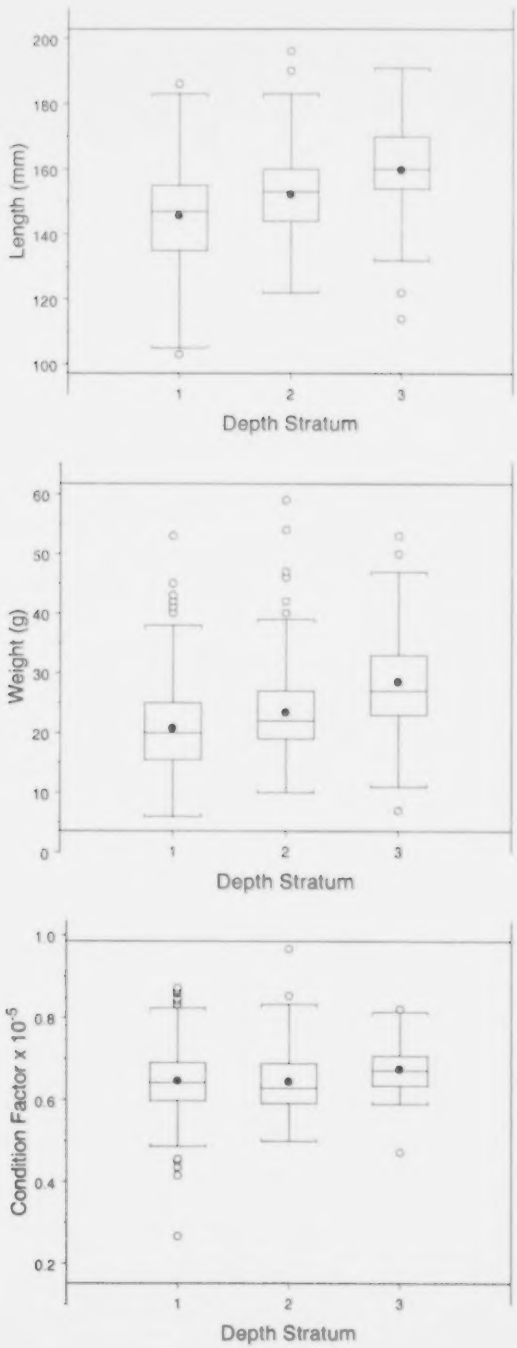

Figure 7. Box plots representing length (mm), weight (g), and condition factor distribution of young-of-the-year lingcod by depth strata (1 = 15-24 m; 2=25-34 m; 3=25-44 m) during the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004. The horizontal line in the centre of each box represents the median, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers while outliers are represented by ○. The mean lengths are represented by ●. See Table 5 for sampling site codes and sample sizes.

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Appendix Table 1. Bridge log information for bottom trawl tows from the2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004. For site names refer to table 5. Depth stratum 1= 15-24 m; depth stratum 2 = 25-34 m; depth stratum 3 = 35-44 m. Habitat type S=Sand, M=Mud, R=Rock. Tows were designated "Unusable" when circumstances required that the net be retrieved early, i.e. rocky bottom snagging the net, or large quantities of kelp fouling the net.

Tow Number	1	2	3	4	5	6	7	8	9
Date	July 13	July 13	July 13	July 14	July 14	July 14	July 14	July 14	July 15
Site	WC	SB	SB	SB	SB	WC	WC	WC	TH
Region	E	E	E	E	E	E	E	E	E
Statistical Area	29	28	28	28	28	29	29	29	16
Depth Stratum	2	2	1	1	2	1	2	1	2
Start Time (PST)	09:26	15:56	16:50	07:24	08:16	13:36	14:28	15:23	07:50
Duration (min)	9	10	10	5	10	5	10	2	9
Start Position									
North Latitude	49° 25.96'	49° 17.4'	49° 17.21'	49° 17.38'	49° 17.58'	49° 25.95'	49° 25.68'	49° 25.52'	49° 30.22'
West Longitude	123° 41.88'	123° 13.34'	123° 12.95'	123° 14.06'	123° 14.82'	123° 41.49'	123° 41.27'	123° 40.75'	124° 2.03'
Finish Position									
North Latitude	49° 25.99'	49° 17.46'	49° 17.3'	49° 17.45'	49° 17.55'	49° 25.82'	49° 25.89'	49° 25.71'	49° 29.93'
West Longitude	123° 42.48'	123° 13.83'	123° 13.42'	123° 13.8'	123° 15.41'	123° 41.28'	123° 41.71'	123° 40.96'	124° 2.22'
Distance Towed (n.mi)	0.36	0.29	0.32	0.29	0.22	0.28	0.46	0.20	0.35
Distance Towed (m)	666.7	537.1	592.6	537.1	407.4	518.6	851.9	370.4	648.2
Vessel Speed (kt)	2.5	2.1	2.2			2.2	2.2	--	2.3
Direction (°True)	106	260	286	99	279	106	295	320	188
Modal Bottom Depth (m)	33.0	30.0	21.0	19.0	35.0	24.0	36.0	--	33.0
Habitat Type	SR	SM	SM	SM	SM	SR	SR	SR	SR
Tide	Low	Flood	Flood	Ebb	Ebb	Flood	Flood	Flood	Ebb
Tide Height (m)	1.0	3.7	4.1	2.1	1.5	2.0	2.7	3.4	2.2
Total Catch (kg)	156.3	128.1	106.8	76.6	138.6	90.5	105.5	0.2	109.7
Number of Lingcod	0	0	0	0	0	0	0	--	0
Swept Area (m^2)	8667	6982	7704	6982	5297	6741	11075	4815	8427
Density (lingcod/km^2)	0	0	0	0	0	0	0	--	0
Useable tow	Y	Y	Y	Y	Y	Y	Y	N	Y

Appendix Table 1 (Cont.)

Tow Number	10	11	12	13	14	15	16	17	18
Date	July 15	July 15	July 16	July 16	July 16	July 16	July 16	July 16	July 16
Site	TH	HW	OB	OB	OB	OB	OB	BC	BC
Region	E	E	N	N	N	N	N	N	N
Statistical Area	16	15	14	14	14	14	14	14	14
Depth Stratum	2	2	1	2	1	2	1	1	2
Start Time (PST)	08:43	12:44	08:18	08:48	09:54	10:41	12:12	13:14	14:07
Duration (min)	1	1	3	9	10	7	10	10	10
Start Position									
North Latitude	--	49° 52.67'	49° 55.26'	49° 54.59'	49° 54.27'	49° 54.02'	49° 54.98'	49° 51.89'	49° 51.94'
West Longitude	--	124° 39.97'	125° 9.01'	125° 8.38'	125° 8.54'	125° 7.79'	125° 9.04'	125° 5.77'	125° 5.53'
Finish Position									
North Latitude	--	49° 52.95'	49° 55.38'	49° 54.81'	49° 54.05'	49° 53.87'	49° 54.71'	49° 52.26'	49° 51.64'
West Longitude	--	124° 39.58'	125° 9.12'	125° 8.78'	125° 8.1'	125° 7.44'	125° 8.66'	125° 6.15'	125° 5.27'
Distance Towed (n.mi)	--	--	0.14	0.35	0.36	0.32	0.35	0.41	0.34
Distance Towed (m)	--	--	259.3	648.2	666.7	592.6	648.2	759.3	629.7
Vessel Speed (kt)	--	1.8	2.0	2.2	2.3	2.3	2.4	2.4	2.3
Direction (°True)	--	40	328	309	128	130	180	338	133
Modal Bottom Depth (m)	--	--	24.0	29.0	21.0	34.0	24.0	18.0	28.0
Habitat Type	--	SR	SR	SR	SR	SR	SR	S	S
Tide	--	Flood	Ebb	Ebb	Ebb	Ebb	Low	Low	Flood
Tide Height (m)	--	0.9	2.5	2.2	1.6	1.3	0.9	1.1	1.6
Total Catch (kg)	--	--	14.8	135.5	112.8	105.3	118.2	145.8	90.2
Number of Lingcod	--	--	1	16	56	8	18	19	12
Swept Area (m^2)	--	--	3371	8427	8667	7704	8427	9871	8186
Density (lingcod/km^2)	--	--	297	1899	6461	1038	2136	1925	1466
Useable tow	N	N	N	Y	Y	Y	Y	Y	Y

Appendix Table 1 (Cont.)

Tow Number	19	20	21	22	23	24	25	26	27
Date	July 16	July 16	July 17	July 17	July 17	July 17	July 17	July 17	July 17
Site	BC	BC	KC	KC	KC	KC	KC	LR	LR
Region	N	N	N	N	N	N	N	N	N
Statistical Area	14	14	14	14	14	14	14	14	14
Depth Stratum	1	2	2	2	1	1	2	2	1
Start Time (PST)	15:05	15:54	08:53	09:16	09:59	11:16	12:49	13:52	14:22
Duration (min)	10	10	2	10	10	10	4	10	10
Start Position									
North Latitude	49° 51.43'	49° 51'	49° 47.81'	49° 48.34'	49° 48.33'	49° 49.47'	49° 49.19'	49° 43.77'	49° 43.58'
West Longitude	125° 5.18'	125° 4.06'	124° 59.3'	124° 59.6'	125° 0.3'	125° 1.25'	125° 0.55'	124° 51.88'	124° 51.71'
Finish Position									
North Latitude	49° 51.21'	49° 51.26'	--	49° 47.95'	49° 48.01'	49° 49.15'	49° 49.08'	49° 43.98'	49° 43.39'
West Longitude	125° 4.72'	125° 4.57'	--	124° 59.54'	124° 59.96'	125° 0.96'	125° 0.34'	124° 52.36'	124° 51.21'
Distance Towed (n.mi)	0.42	0.43	--	0.38	0.46	0.39	0.26	0.39	0.40
Distance Towed (m)	777.8	796.4	--	703.8	851.9	722.3	481.5	722.3	740.8
Vessel Speed (kt)	2.4	2.5	2.4	2.4	2.4	2.3	2.4	2.5	2.4
Direction (°True)	121	305	149	161	144	138	131	301	121
Modal Bottom Depth (m)	22.0	34.0	32.0	34.0	22.0	24.0	32.0	34.0	16.0
Habitat Type	S	S	S	S	SR	SR	SR	S	SR
Tide	Flood	Flood	Ebb	Ebb	Ebb	Ebb	Low	Flood	Flood
Tide Height (m)	2.4	3.2	2.6	2.6	1.9	1.2	0.9	1.3	1.6
Total Catch (kg)	133.7	30.0	--	100.1	211.2	186.4	31.2	28.5	153.5
Number of Lingcod	12	8	--	0	21	41	2	2	7
Swept Area (m^2)	10112	10353	--	9149	11075	9390	6260	9390	9630
Density (lingcod/km^2)	1187	773	--	0	1896	4367	320	213	727
Useable tow	Y	Y	N	Y	Y	Y	N	Y	Y

Appendix Table 1 (Cont.)

Tow Number	28	29	30	31	32	33	34	35	36
Date	July 17	July 18	July 18	July 18	July 18	July 18	July 18	July 18	July 19
Site	CL	CL	CL	CL	CX	CX	CX	CX	BW
Region	N	N	N	N	N	N	N	N	N
Statistical Area	14	14	14	14	14	14	14	14	14
Depth Stratum	1	2	2	1	2	2	1	1	2
Start Time (PST)	15:19	06:21	07:43	08:48	10:43	12:04	12:47	13:55	07:42
Duration (min)	10	11	10	8	7	10	10	11	10
Start Position									
North Latitude	49° 41.04'	49° 40.57'	49° 40.38'	49° 40.86'	49° 39.18'	49° 38.57'	49° 37.87'	49° 37.06'	49° 26.92'
West Longitude	124° 50.97'	124° 51.85'	124° 51.96'	124° 51.82'	124° 53.11'	124° 53.66'	124° 54.36'	124° 53.6'	124° 39.54'
Finish Position									
North Latitude	49° 41.07'	49° 40.92'	49° 40.04'	49° 40.65'	49° 39.04'	49° 38.91'	49° 38.19'	49° 37.43'	49° 27.2'
West Longitude	124° 51.53'	124° 51.59'	124° 52.01'	124° 51.95'	124° 54.52'	124° 53.95'	124° 54.57'	124° 53.86'	124° 39.97'
Distance Towed (n.mi)	0.38	0.41	0.39	0.33	0.32	0.40	0.39	0.41	0.51
Distance Towed (m)	703.8	759.3	722.3	611.2	592.6	740.8	722.3	759.3	944.5
Vessel Speed (kt)	2.4	2.3	2.3	2.2	2.4	2.4	2.0	2.3	2.3
Direction (°True)	272	9	195	211	233	336	340	333	313
Modal Bottom Depth (m)	20.0	34.0	35.0	24.0	34.0	34.0	24.0	22.0	32.0
Habitat Type	S	S	S	S	SM	S	SM	SM	S
Tide	Flood	High	Ebb	Ebb	Ebb	Ebb	Low	Low	High
Tide Height (m)	2.3	4.2	3.9	3.0	2.0	1.2	0.9	0.9	4.1
Total Catch (kg)	163.0	512.6	347.0	28.1	116.4	22.0	145.1	64.2	116.7
Number of Lingcod	12	40	45	20	7	0	20	30	16
Swept Area (m^2)	9149	9871	9390	7945	7704	9630	9390	9871	12279
Density (lingcod/km^2)	1312	4052	4793	2517	909	0	2130	3039	1303
Useable tow	Y	Y	Y	Y	Y	Y	Y	Y	Y

Appendix Table 1 (Cont.)

Tow Number	37	38	39	40	41	42	43	44	45
Date	July 19	July 19	July 19	July 19	July 22	July 22	July 22	July 22	July 23
Site	BW	BW	BW	QU	KP	KP	KP	KP	FH
Region	N	N	N	N	S	S	S	S	S
Statistical Area	14	14	14	14	17	17	17	17	18
Depth Stratum	1	1	2	1	2	1	1	1	2
Start Time (PST)	08:32	09:15	09:56	10:48	15:10	15:55	16:38	17:07	07:24
Duration (min)	10	10	10	10	10	10	10	10	10
Start Position									
North Latitude	49° 27.02'	49° 26.37'	49° 26.23'	49° 24.66'	49° 1.14'	49° 0.24'	48° 57.99'	48° 57.18'	48° 44.35'
West Longitude	124° 40.09'	124° 39.56'	124° 38.66'	124° 36.01'	123° 38.99'	123° 38.86'	123° 37.52'	123° 37.46'	123° 25.49'
Finish Position									
North Latitude	49° 27.29'	49° 26.7'	49° 26.54'	49° 24.85'	49° 1.32'	49° 0.53'	48° 57.6'	48° 57.6'	48° 44.74'
West Longitude	124° 40.46'	124° 39.9'	124° 39'	124° 36.54'	123° 39.49'	123° 39.18'	123° 37.41'	123° 37.48'	123° 25.73'
Distance Towed (n.mi)	0.39	0.43	0.43	0.50	0.36	0.40	0.41	0.39	0.41
Distance Towed (m)	722.3	796.4	796.4	926.0	666.7	740.8	759.3	722.3	759.3
Vessel Speed (kt)	2.3	2.3	2.2	2.4	2.3	2.3	2.3	2.4	2.5
Direction (°True)	311	317	232	300	293	320	168	356	221
Modal Bottom Depth (m)	22.0	19.0	32.0	18.0	35.0	25.0	23.0	23.0	32.0
Habitat Type	SR	SR	SR	SR	SM	S	S	S	S
Tide	Ebb	Ebb	Ebb	Ebb	Low	Flood	Flood	Flood	Flood
Tide Height (m)	3.7	3.3	2.6	2.0	1.2	1.4	1.6	1.8	2.2
Total Catch (kg)	289.0	107.4	149.5	275.4	88.4	71.8	162.4	133.1	192.7
Number of Lingcod	13	6	11	27	0	0	0	0	0
Swept Area (m^2)	9390	10353	10353	12038	8667	9630	9871	9390	9871
Density (lingcod/km^2)	1385	580	1063	2243	0	0	0	0	0
Useable tow	Y	Y	Y	Y	Y	Y	Y	Y	Y

Appendix Table 1 (Cont.)

Tow Number	46	47	48	49	50	51	52	53	54
Date	July 23	July 23	July 23	July 23	July 23	July 23	July 23	July 24	July 24
Site	FH	FH	SD	SD	WH	WH	WH	KP	KP
Statistical Area	18	18	19	19	18	18	18	17	17
Depth Stratum	1	1	2	1	2	1	1	1	2
Start Time (PST)	08:17	08:54	10:11	11:09	16:06	16:49	17:16	08:03	08:45
Duration (min)	10	10	10	10	10	10	10	9	8
Start Position									
North Latitude	48° 45.01'	48° 45.51'	48° 38.35'	48° 36.84'	48° 54.18'	48° 39.4'	48° 54.37'	49° 7.56'	49° 7.41'
West Longitude	123° 26.04'	123° 26.56'	123° 21.17'	123° 23.58'	123° 29.73'	123° 29.89'	123° 30.39'	123° 43.55'	123° 45.16'
Finish Position									
North Latitude	48° 44.7'	48° 45.22'	48° 38.68'	48° 37.17'	48° 54.43'	48° 54.17'	48° 54.71'	49° 7.47'	49° 7.45'
West Longitude	123° 25.8'	123° 26.3'	123° 21.22'	123° 23.69'	123° 30.2'	123° 30.32'	123° 30.64'	123° 44.09'	123° 44.65'
Distance Towed (n.mi)	0.35	0.38	0.37	0.36	0.34	0.46	0.45	0.37	0.21
Distance Towed (m)	648.2	703.8	685.2	666.7	629.7	851.9	833.4	685.2	388.9
Vessel Speed (kt)	2.2	2.2	2.1	2.3	2.4	2.2	2.2	2.3	2.3
Direction (°True)	144	147	348	335	303	310	327	249	81
Modal Bottom Depth (m)	22.0	23.0	34.0	22.0	27.0	20.0	25.0	17.0	25.0
Habitat Type	SR	S	SR	S	SM	S	S	SR	SR
Tide	Flood	High	High	Ebb	Low	Flood	Flood	Flood	Flood
Tide Height (m)	2.3	2.3	2.3	2.2	1.5	1.7	1.7	2.3	2.5
Total Catch (kg)	176.9	168.2	58.3	635.3	37.3	61.4	46.3	74.3	148.1
Number of Lingcod	0	0	0	16	0	1	0	5	4
Swept Area (m^2)	8427	9149	8908	8667	8186	11075	10834	8908	5056
Density (lingcod/km^2)	0	0	0	1846	0	90	0	561	791
Useable tow	Y	Y	Y	Y	Y	Y	Y	Y	Y

Appendix Table 1 (Cont.)

Tow Number	55	56	57	58	59	60	61	62	63
Date	July 24	July 24	July 24	July 24	July 24	July 25	July 25	July 25	July 25
Site	KP	NS	NS	NS	NS	NS	FC	FC	FC
Region	S	S	S	S	S	S	N	N	N
Statistical Area	17	17	17	17	17	17	14	14	14
Depth Stratum	2	2	1	1	2	2	2	2	1
Start Time (PST)	09:42	15:36	16:23	17:02	17:31	07:46	09:00	10:05	10:39
Duration (min)	4	10	10	9	10	9	10	10	10
Start Position									
North Latitude	49° 7.16'	49° 15.69'	49° 15.54'	49° 15.34'	49° 15.68'	49° 15.74'	49° 18.64'	49° 20.44'	49° 20.41'
West Longitude	123° 45.27'	124° 9.4'	124° 9.64'	124° 8.16'	124° 8.86'	124° 6.61'	124° 13.87'	124° 19.81'	124° 18.94'
Finish Position									
North Latitude	49° 7.33'	49° 15.74'	49° 15.61'	49° 15.51'	49° 15.5'	49° 15.64'	49° 18.96'	49° 20.19'	49° 20.17'
West Longitude	123° 45.29'	124° 10.04'	124° 10.16'	124° 8.69'	124° 8.29'	124° 6.06'	124° 14.25'	124° 18.28'	124° 18.61'
Distance Towed (n.mi)	--	0.43	0.44	0.43	0.44	0.36	0.40	0.44	0.35
Distance Towed (m)	--	796.4	814.9	796.4	814.9	666.7	740.8	814.9	648.2
Vessel Speed (kt)	2.0	2.0	2.2	2.2	2.4	2.5	2.2	2.5	2.4
Direction (°True)	350	274	287	286	116	107	319	112	137
Modal Bottom Depth (m)	27.0	26.0	23.0	24.0	32.0	34.0	33.0	34.0	22.0
Habitat Type	SR	SM	SM	SG	SM	S	SR	S	S
Tide	Flood	Ebb	Low	Low	Low	Low	Flood	Flood	Flood
Tide Height (m)	2.6	2.7	2.6	2.6	2.7	2.0	2.4	2.8	2.8
Total Catch (kg)	26.0	266.1	189.9	213.7	214.5	137.0	69.7	46.5	246.8
Number of Lingcod	2	2	2	5	2	8	13	29	54
Swept Area (m^2)	--	10353	10593	10353	10593	8667	9630	10593	8427
Density (lingcod/km^2)	--	193	189	483	189	923	1350	2738	6408
Useable tow	N	Y	Y	Y	Y	Y	Y	Y	Y

Appendix Table 1 (Cont.)

Tow Number	64	65	66	67	68	69	70	71
Date	July 25	July 25	July 25	July 25	July 25	July 26	July 26	July 26
Site	QU	QU	QU	QU	QU	NM	NM	NM
Region	N	N	N	N	N	S	S	S
Statistical Area	14	14	14	14	14	17	17	17
Depth Stratum	2	1	2	3	3	2	3	1
Start Time (PST)	12:15	12:53	13:49	14:14	14:49	06:54	07:31	08:29
Duration (min)	6	10	10	10	10	6	10	4
Start Position								
North Latitude	49° 23.63'	49° 23.53'	49° 24.62'	49° 24.78'	49° 23.83'	49° 13.19'	49° 14.98'	49° 12.02'
West Longitude	124° 34.54'	124° 34.91'	124° 35.69'	124° 35.58'	124° 34.23'	123° 56.3'	123° 59.9'	123° 55.09'
Finish Position								
North Latitude	49° 23.51'	49° 23.39'	49° 24.81'	49° 24.63'	49° 23.57'	49° 13.03'	49° 15.23'	49° 12.09'
West Longitude	124° 34.19'	124° 34.38'	124° 36.21'	124° 35.17'	124° 33.94'	123° 55.91'	124° 0.34'	123° 55.23'
Distance Towed (n.mi)	0.32	0.39	0.38	0.40	0.47	0.38	0.38	0.25
Distance Towed (m)	592.6	722.3	703.8	740.8	870.4	703.8	703.8	463.0
Vessel Speed (kt)	2.4	2.4	2.5	2.3	2.6	2.4	2.5	2.3
Direction (°True)	116	109	301	119	138	121	301	313
Modal Bottom Depth (m)	35.0	23.0	33.0	43.0	44.0	33.0	40.0	22.0
Habitat Type	S	S	S	S	S	SM	S	S
Tide	High	High	High	Ebb	Ebb	Low	Low	Low
Tide Height (m)	3.5	3.6	3.6	3.5	3.6	1.4	1.3	1.3
Total Catch (kg)	172.0	422.0	51.1	261.3	227.1	7.9	58.8	32.1
Number of Lingcod	5	25	7	31	10	0	16	2
Swept Area (m^2)	7704	9390	9149	9630	11316	9149	9149	6019
Density (lingcod/km^2)	649	2663	765	3219	884	0	1749	332
Useable tow	Y	Y	Y	Y	Y	Y	Y	N

Appendix Table 2. Fish species catch composition (kg) for usable bottom trawl tows from the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004. Species with < 1 kg total catch (all tows combined) were included in "Other Fish." For a complete list of all species captured, refer to Table 2.

	Catch (kg)										
Tow Number	1	2	3	4	5	6	7	9	13	14	15
Spiny dogfish	3.4	20.1	18.1	27.8	12.1	6.2	3.5	7.8	35.8	--	3.1
Big skate	--	--	--	--	--	--	--	--	--	--	--
Longnose skate	--	--	--	--	--	--	--	--	--	--	--
Spotted ratfish	--	--	--	--	--	--	--	--	31.1	--	47.8
Pacific herring	--	0.2	0.2	0.1	--	--	--	--	--	--	--
Longfin smelt	--	0.2	0.4	0.3	0.1	--	--	--	--	--	--
Plainfin midshipman	0.3	--	--	--	--	0.2	0.6	0.8	1.3	0.7	0.2
Pacific cod	--	--	--	0.1	--	--	--	--	0.1	0.1	0.1
Pacific hake	--	--	--	--	0.2	--	--	--	--	--	--
Pacific tomcod	0.3	--	0.2	0.3	0.1	--	0.2	0.4	--	--	--
Walleye pollock	--	--	--	--	--	--	--	--	--	--	--
Blackbelly eelpout	0.3	56.9	23.8	11.7	24.2	0.1	3.7	--	--	--	--
Tube snouts	--	--	--	--	--	--	--	--	--	--	--
Shiner perch	3.1	0.5	0.7	0.6	0.5	4.4	4.3	1.6	--	--	--
Striped seaperch	--	--	--	--	--	--	--	--	--	--	--
Snake prickleback	1.7	1.0	7.3	11.1	0.2	0.3	0.4	--	--	--	--
Copper rockfish	0.1	--	--	--	--	--	--	--	1.8	--	2.2
Quillback rockfish	--	--	--	--	0.4	--	8.0	0.1	--	--	0.3
Kelp greenling	0.1	--	--	--	--	--	0.3	0.2	--	--	0.2
Whitespotted greenling	0.4	0.9	0.4	0.1	1.0	0.4	0.3	--	--	0.1	--
Lingcod	--	--	--	--	--	--	0.3	--	1.1	1.3	0.2
Longspine combfish	--	--	--	--	--	--	--	--	--	--	--
Roughback sculpin	3.4	--	--	--	--	1.0	2.2	0.6	0.2	0.1	0.1
Threadfin sculpin	--	--	--	--	--	--	--	--	1.4	--	1.8
Pacific staghorn sculpin	--	0.5	0.7	--	0.7	--	--	--	--	--	--
Great sculpin	--	--	--	--	--	--	--	--	--	--	--
Cabezon	--	--	--	--	--	--	--	--	--	--	--
Ribbed sculpin	--	--	--	--	--	--	--	--	--	--	--
Sturgeon poacher	--	--	--	--	--	--	--	0.1	--	--	--
Pacific sanddab	16.0	3.0	4.6	1.4	13.0	8.4	4.3	28.8	--	--	--
Speckled sanddab	0.6	--	1.1	0.3	--	1.7	0.4	0.1	--	0.9	--
Rex sole	0.3	0.5	0.2	0.3	1.6	0.7	0.4	0.8	--	--	--
Flathead sole	--	4.0	2.2	0.3	4.8	0.1	--	--	--	--	--
Butter sole	--	--	--	0.3	0.1	--	--	--	--	--	--
Rock sole	49.9	1.2	8.2	1.4	0.5	30.2	31.9	48.0	46.6	86.0	7.3
Slender sole	0.6	0.2	--	--	0.5	0.1	1.9	3.0	--	--	--
Dover sole	--	--	0.1	--	0.5	0.5	--	--	--	--	--
English sole	65.3	18.9	25.6	8.9	43.1	27.0	25.2	17.2	10.6	21.8	3.1
Starry flounder	--	8.4	3.1	3.6	15.7	3.7	--	--	--	--	--
C-O sole	--	--	--	--	--	--	--	--	--	0.9	2.0
Sand sole	--	0.7	--	--	0.2	--	--	--	--	0.2	--
Other fish	--	--	--	--	0.4	--	0.4	0.2	--	--	0.4
Total	145.7	117.4	96.9	68.5	119.7	85.0	88.2	109.7	130.1	112.3	68.8

Appendix Table 2. (Cont.)

	Catch (kg)										
Tow Number	16	17	18	19	20	22	23	24	26	27	28
Spiny dogfish	28.9	21.9	34.3	27.7	--	10.0	27.5	56.3	2.6	80.0	16.9
Big skate	--	--	--	--	--	--	15.4	--	--	--	--
Longnose skate	--	3.3	--	7.6	--	--	1.0	--	--	--	--
Spotted ratfish	1.8	--	--	--	--	0.9	--	--	19.1	1.3	--
Pacific herring	--	--	--	--	--	--	--	--	--	--	--
Longfin smelt	--	--	--	--	--	--	--	--	--	--	--
Plainfin midshipman	0.3	1.0	0.5	0.4	1.0	0.3	1.7	1.2	--	--	4.2
Pacific cod	2.7	0.1	0.1	0.1	0.1	27.9	0.2	10.7	0.1	0.4	0.1
Pacific hake	--	--	--	--	--	--	--	--	--	--	--
Pacific tomcod	--	--	--	--	--	--	--	--	0.1	--	--
Walleye pollock	0.2	--	--	--	--	--	--	--	--	0.1	--
Blackbelly eelpout	--	--	--	--	--	--	--	--	--	--	--
Tube snouts	--	--	--	--	--	--	--	--	--	--	--
Shiner perch	--	--	--	--	--	--	--	--	--	--	0.1
Striped seaperch	--	--	--	--	--	--	--	--	--	--	--
Snake prickleback	--	0.1	--	--	--	--	--	--	0.1	0.1	0.5
Copper rockfish	1.4	--	--	--	--	--	--	--	0.8	--	--
Quillback rockfish	--	--	--	--	--	--	--	--	--	--	--
Kelp greenling	--	--	--	--	--	--	--	--	--	--	--
Whitespotted greenling	--	0.1	0.1	0.2	--	--	--	0.1	--	--	0.1
Lingcod	0.4	0.5	0.2	0.3	0.6	--	0.1	1.0	0.1	0.1	0.2
Longspine combfish	--	--	0.2	--	--	--	0.2	--	--	--	--
Roughback sculpin	0.2	0.1	0.2	0.4	0.1	0.2	1.0	1.6	--	0.7	0.2
Threadfin sculpin	--	--	--	--	0.2	0.2	--	--	0.1	--	--
Pacific staghorn sculpin	--	--	--	--	--	--	--	--	--	0.1	--
Great sculpin	--	--	--	--	--	--	--	0.1	--	--	0.4
Cabezon	--	--	--	--	--	--	--	--	--	--	--
Ribbed sculpin	--	--	--	--	--	--	--	--	--	--	--
Sturgeon poacher	--	--	0.2	0.1	0.1	0.1	1.2	0.1	--	0.1	0.2
Pacific sanddab	--	1.0	--	0.7	--	6.1	1.0	--	--	--	--
Speckled sanddab	0.3	3.1	1.8	2.9	0.6	0.3	3.2	4.2	0.2	0.4	5.4
Rex sole	--	--	--	--	--	--	--	--	--	--	--
Flathead sole	--	--	--	--	--	--	--	--	--	--	--
Butter sole	--	--	--	--	--	--	--	--	--	--	--
Rock sole	65.1	41.4	25.7	49.2	4.2	20.3	64.8	35.3	1.7	35.4	93.5
Slender sole	--	--	0.2	--	--	0.3	--	--	--	--	0.2
Dover sole	--	--	--	--	--	--	--	--	--	--	--
English sole	15.1	71.3	24.3	31.3	11.1	31.8	75.4	72.8	3.3	25.2	28.2
Starry flounder	--	--	--	--	--	--	--	--	--	1.0	--
C-O sole	1.3	1.8	1.9	4.9	0.2	0.5	17.4	1.6	0.2	6.3	6.7
Sand sole	--	--	--	--	--	--	--	--	--	--	--
Other fish	0.1	--	0.2	--	--	--	0.1	--	--	--	--
Total	117.7	145.8	89.7	126.0	18.2	99.0	210.3	185.2	28.4	151.4	157.1

Appendix Table 2. (Cont.)

Tow Number	Catch (kg) 29	30	31	32	33	34	35	36	37	38	39
Spiny dogfish	27.5	11.7	8.8	1.2	5.1	14.7	6.3	52.2	216.1	47.7	45.0
Big skate	1.6	--	0.1	--	--	1.0	1.7	--	--	--	--
Longnose skate	--	--	--	--	--	0.1	--	--	--	--	--
Spotted ratfish	29.2	10.3	--	--	--	--	--	--	--	--	--
Pacific herring	--	--	--	0.1	--	0.1	6.8	--	--	--	--
Longfin smelt	--	--	--	--	--	--	--	--	--	--	--
Plainfin midshipman	10.1	2.5	1.2	0.3	1.8	1.6	0.7	3.2	0.1	0.2	1.9
Pacific cod	0.5	0.3	0.8	--	--	--	--	0.1	0.1	0.1	--
Pacific hake	--	--	--	--	--	--	--	--	--	--	--
Pacific tomcod	--	--	0.1	0.1	--	0.3	0.7	0.3	0.1	--	0.6
Walleye pollock	9.3	3.1	--	--	--	--	--	--	--	--	--
Blackbelly eelpout	1.7	0.6	--	6.7	--	35.7	8.8	--	--	--	--
Tube snouts	--	--	--	--	--	--	--	--	--	--	--
Shiner perch	--	0.1	0.1	--	--	0.5	0.3	0.1	1.0	1.4	0.4
Striped seaperch	--	--	--	--	--	--	--	--	--	--	--
Snake prickleback	1.7	0.3	0.1	0.2	--	1.6	0.7	0.1	0.1	0.1	0.1
Copper rockfish	--	1.0	--	--	--	--	--	--	--	--	--
Quillback rockfish	--	--	--	--	--	--	--	--	--	--	--
Kelp greenling	--	--	--	--	--	--	--	--	--	--	--
Whitespotted greenling	--	--	0.1	--	--	--	--	--	0.3	0.2	--
Lingcod	0.9	1.1	0.5	0.2	--	0.4	0.6	0.5	0.3	0.1	0.3
Longspine combfish	0.4	--	--	--	--	--	--	0.4	--	--	0.2
Roughback sculpin	0.1	0.3	0.3	--	--	--	--	0.4	0.3	0.5	0.2
Threadfin sculpin	--	--	--	--	--	--	--	--	--	--	--
Pacific staghorn sculpin	0.4	0.3	0.5	0.1	0.1	--	0.2	--	0.3	0.2	--
Great sculpin	0.9	4.4	4.0	--	--	--	--	--	--	--	--
Cabezon	4.7	--	--	--	--	--	--	--	--	--	--
Ribbed sculpin	--	--	--	--	--	--	--	--	--	--	--
Sturgeon poacher	0.1	0.1	--	--	--	--	--	--	0.1	--	--
Pacific sanddab	--	--	--	--	--	--	--	--	--	--	0.8
Speckled sanddab	--	--	0.4	--	--	2.5	1.1	2.2	2.3	2.0	0.3
Rex sole	--	--	--	--	--	--	--	--	--	--	0.1
Flathead sole	0.4	2.2	--	0.7	--	6.5	4.2	--	--	--	--
Butter sole	--	--	--	--	--	--	--	--	--	--	--
Rock sole	249.9	198.9	4.5	0.1	--	0.1	0.9	25.4	53.9	30.7	45.5
Slender sole	2.5	4.2	0.1	0.1	--	--	--	1.3	--	--	3.0
Dover sole	--	--	--	--	--	--	--	--	--	--	0.6
English sole	106.6	66.0	1.8	4.6	0.1	22.9	10.8	28.8	12.2	18.3	42.5
Starry flounder	57.5	27.2	--	0.4	--	11.4	3.5	--	--	--	4.2
C-O sole	--	--	--	--	--	--	--	--	0.5	0.3	--
Sand sole	0.8	0.8	--	--	--	0.1	1.3	--	--	--	--
Other fish	--	--	0.3	0.1	--	--	--	--	--	--	--
Total	506.9	335.1	23.7	14.9	7.1	99.6	48.6	114.9	287.8	101.6	145.9

Appendix Table 2. (Cont.)

	Catch (kg)										
Tow Number	40	41	42	43	44	45	46	47	48	49	50
Spiny dogfish	193.6	28.0	14.3	20.6	17.3	7.7	30.9	28.7	21.0	510.0	8.4
Big skate	--	--	--	--	--	--	--	--	--	--	--
Longnose skate	--	--	--	--	--	--	--	--	--	--	--
Spotted ratfish	--	--	--	--	--	--	--	--	--	--	--
Pacific herring	--	0.2	0.4	0.1	0.6	0.3	--	--	--	--	0.4
Longfin smelt	--	--	--	0.1	--	--	--	0.1	--	--	--
Plainfin midshipman	0.1	1.0	0.5	2.6	4.1	0.1	0.1	1.1	--	--	1.1
Pacific cod	0.7	--	--	--	--	--	0.3	--	0.2	0.4	0.1
Pacific hake	--	1.5	--	--	0.6	--	0.1	--	--	--	--
Pacific tomcod	--	4.7	6.0	2.2	0.9	2.7	0.5	0.7	0.8	--	2.0
Walleye pollock	--	--	--	--	--	--	--	--	--	--	--
Blackbelly eelpout	--	8.2	3.4	3.5	--	3.0	--	1.8	--	--	--
Tube snouts	--	--	--	--	--	--	--	--	--	--	--
Shiner perch	0.4	0.2	2.7	1.3	2.1	1.3	0.8	6.9	--	2.4	0.8
Striped seaperch	--	--	--	--	--	--	--	--	--	--	--
Snake prickleback	0.1	0.4	0.1	0.3	0.9	5.1	1.1	0.7	--	0.6	1.6
Copper rockfish	--	--	--	--	--	--	--	--	--	--	--
Quillback rockfish	--	--	--	--	--	--	--	--	--	--	--
Kelp greenling	--	--	--	--	--	--	--	--	--	--	--
Whitespotted greenling	0.3	0.3	0.1	0.4	0.1	--	0.4	--	--	0.1	0.0
Lingcod	0.4	--	--	--	--	--	0.3	--	--	0.2	--
Longspine combfish	--	1.1	1.1	0.1	0.1	--	0.1	--	--	--	--
Roughback sculpin	0.4	0.1	0.2	--	0.1	--	1.4	0.6	0.2	--	0.1
Threadfin sculpin	--	--	--	--	--	--	--	--	--	--	--
Pacific staghorn sculpin	0.1	0.0	0.2	--	0.6	--	1.4	--	0.4	--	--
Great sculpin	--	--	--	--	--	--	--	--	0.1	--	--
Cabezon	--	--	--	--	--	--	--	--	--	--	--
Ribbed sculpin	--	--	--	--	--	--	--	--	1.0	--	--
Sturgeon poacher	--	--	--	--	--	0.1	0.3	0.1	--	0.2	0.4
Pacific sanddab	--	6.0	--	--	2.6	34.4	11.8	5.1	--	--	0.8
Speckled sanddab	0.2	--	0.4	--	--	--	0.8	0.4	--	0.1	--
Rex sole	--	--	--	0.1	--	0.3	--	--	--	--	--
Flathead sole	--	3.4	5.4	5.7	11.5	4.0	0.3	1.8	--	--	2.1
Butter sole	--	--	--	--	--	--	--	--	--	--	--
Rock sole	75.3	8.5	13.2	5.7	6.2	24.9	39.4	8.7	1.6	21.0	9.0
Slender sole	--	0.2	0.1	--	0.6	0.3	0.3	0.1	0.1	--	--
Dover sole	--	--	--	--	--	--	0.5	1.1	--	--	--
English sole	1.4	20.4	13.8	54.2	35.9	96.3	54.4	99.4	0.2	82.0	9.3
Starry flounder	--	--	0.4	42.1	39.1	0.7	--	--	--	10.4	--
C-O sole	--	--	--	--	--	--	0.3	--	--	--	--
Sand sole	--	0.8	0.9	9.9	7.4	--	--	1.1	--	--	--
Other fish	--	0.1	--	--	--	0.1	0.3	0.1	0.4	0.4	--
Total	272.9	85.1	63.1	148.9	130.5	181.5	145.7	158.5	26.0	627.8	36.1

Appendix Table 2. (Cont.)

	Catch (kg)										
Tow Number	51	52	53	54	56	57	58	59	60	61	62
Spiny dogfish	10.6	--	16.0	35.2	8.7	1.0	35.2	12.4	9.0	1.8	11.8
Big skate	--	--	--	--	--	--	--	--	--	--	--
Longnose skate	--	--	--	--	--	--	--	--	--	--	--
Spotted ratfish	--	--	--	--	6.0	--	--	--	--	--	--
Pacific herring	0.1	0.1	--	--	0.1	--	0.1	0.1	0.8	--	--
Longfin smelt	--	--	--	--	--	--	--	--	--	--	--
Plainfin midshipman	1.9	2.8	--	0.1	0.1	--	1.0	0.3	0.6	1.5	2.4
Pacific cod	--	0.1	0.3	0.1	0.1	--	0.1	--	0.1	0.1	1.2
Pacific hake	--	--	--	--	--	--	--	--	--	--	--
Pacific tomcod	0.7	0.9	--	0.6	--	0.6	2.8	2.1	1.2	0.2	0.1
Walleye pollock	--	--	--	--	4.0	--	5.5	2.4	1.2	--	--
Blackbelly eelpout	--	0.1	--	0.1	0.1	0.1	0.1	1.5	0.5	--	--
Tube snouts	--	--	1.0	--	--	--	--	--	--	--	--
Shiner perch	1.3	0.9	0.7	0.2	2.7	0.6	0.3	4.1	0.6	--	0.5
Striped seaperch	--	1.5	--	--	--	--	--	--	--	--	--
Snake prickleback	1.6	1.2	--	0.3	--	--	--	0.1	--	--	0.1
Copper rockfish	--	--	--	--	--	--	--	--	--	--	--
Quillback rockfish	--	--	--	--	--	--	--	--	--	0.1	--
Kelp greenling	--	--	--	--	--	--	--	--	--	--	--
Whitespotted greenling	1.1	0.1	0.3	0.5	--	--	--	--	--	--	0.1
Lingcod	0.1	--	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.7
Longspine combfish	--	--	--	0.6	--	--	--	--	--	--	--
Roughback sculpin	0.1	0.1	0.1	2.0	0.1	--	0.1	--	0.3	0.2	0.3
Threadfin sculpin	--	--	--	--	--	--	--	--	--	--	--
Pacific staghorn sculpin	--	0.1	--	--	0.3	0.6	0.3	0.1	0.4	--	--
Great sculpin	--	--	--	2.3	--	--	--	--	--	--	--
Cabezon	--	--	--	--	--	--	--	--	--	--	--
Ribbed sculpin	--	--	--	--	--	--	--	--	--	--	--
Sturgeon poacher	0.1	0.1	--	--	--	--	--	--	--	--	--
Pacific sanddab	1.9	1.0	--	--	--	--	--	--	1.9	3.3	1.4
Speckled sanddab	--	--	0.1	2.0	0.1	0.1	0.3	--	0.3	0.4	0.1
Rex sole	--	--	--	--	--	--	--	--	0.4	--	--
Flathead sole	0.8	1.2	--	--	1.0	1.9	1.4	0.9	0.3	--	--
Butter sole	0.4	0.7	--	--	--	--	--	--	--	--	--
Rock sole	13.8	17.4	49.5	52.4	128.3	122.3	77.3	65.1	26.8	22.7	14.7
Slender sole	--	--	--	0.3	--	--	--	0.1	0.1	1.1	0.1
Dover sole	--	--	--	--	--	--	--	--	--	--	--
English sole	15.6	14.7	0.1	45.9	3.6	17.1	27.3	7.1	10.5	25.8	8.1
Starry flounder	6.9	--	--	--	87.9	27.9	22.4	96.3	81.1	10.2	4.0
C-O sole	--	--	--	--	--	--	--	--	--	--	--
Sand sole	--	--	--	--	0.1	0.6	2.1	--	--	--	--
Other fish	--	0.1	0.2	--	--	--	--	--	0.1	--	--
Total	57.1	43.1	68.5	142.5	243.2	173.0	176.6	192.6	136.3	67.7	45.6

Appendix Table 2. (Cont.)

	Catch (kg)								
Tow Number	63	64	65	66	67	68	69	70	All tows
Spiny dogfish	142.8	18.6	229.1	42.6	67.5	51.8	2.8	13.9	2471.6
Big skate	--	--	--	--	--	--	--	--	19.8
Longnose skate	--	--	--	--	--	--	--	--	12.1
Spotted ratfish	--	--	--	--	--	--	--	0.2	147.7
Pacific herring	--	0.1	--	0.1	0.1	0.4	--	--	11.6
Longfin smelt	--	--	--	--	--	--	--	--	1.3
Plainfin midshipman	0.9	0.5	0.1	--	4.1	5.0	--	1.7	72.0
Pacific cod	1.8	0.5	1.0	0.1	2.1	0.4	0.1	0.5	55.1
Pacific hake	--	--	--	--	--	--	--	--	2.4
Pacific tomcod	--	1.4	0.6	0.2	7.9	1.2	--	0.1	44.8
Walleye pollock	--	--	--	--	--	--	--	--	25.7
Blackbelly eelpout	--	0.4	--	--	1.8	3.1	0.1	--	201.8
Tube snouts	--	--	--	--	--	--	--	--	1.0
Shiner perch	0.7	1.8	4.7	0.5	1.8	0.8	--	2.6	63.3
Striped seaperch	--	--	--	--	--	--	--	--	1.5
Snake prickleback	--	0.1	0.3	0.3	0.1	0.1	--	0.1	43.0
Copper rockfish	--	--	--	--	--	--	--	--	7.3
Quillback rockfish	--	--	--	--	--	--	--	0.1	9.0
Kelp greenling	--	--	--	--	--	--	--	--	0.8
Whitespotted greenling	2.8	--	0.9	--	0.1	--	--	--	12.4
Lingcod	1.1	0.2	0.5	0.2	0.7	0.4	--	2.3	19.5
Longspine combfish	--	--	--	--	1.2	--	--	0.1	5.8
Roughback sculpin	0.6	--	0.3	0.1	0.1	--	--	0.7	22.6
Threadfin sculpin	--	--	--	--	--	--	--	--	3.6
Pacific staghorn sculpin	--	0.7	0.6	0.1	--	0.8	--	--	10.9
Great sculpin	--	0.7	--	--	--	--	--	--	12.9
Cabezon	37.1	--	--	--	--	--	--	--	41.8
Ribbed sculpin	--	--	--	--	--	--	--	--	1.0
Sturgeon poacher	--	--	--	--	0.3	--	--	--	4.2
Pacific sanddab	--	--	1.9	0.3	--	1.2	--	4.9	167.6
Speckled sanddab	1.3	--	0.1	--	--	--	0.1	0.1	45.2
Rex sole	--	--	--	--	0.9	0.8	--	4.8	12.1
Flathead sole	--	--	--	--	--	3.8	--	--	71.0
Butter sole	--	--	--	--	--	--	--	--	1.5
Rock sole	44.0	47.7	120.0	4.9	39.0	38.0	3.0	11.9	2470.0
Slender sole	--	0.7	0.1	0.1	3.5	0.8	0.1	0.2	27.0
Dover sole	--	--	--	--	--	3.1	--	--	6.4
English sole	11.0	96.8	60.0	1.6	130.1	109.9	0.9	10.9	2035.5
Starry flounder	--	--	--	--	--	5.8	--	1.7	576.7
C-O sole	0.6	--	--	--	--	--	--	--	47.5
Sand sole	--	--	1.3	--	--	--	--	--	28.4
Other fish	--	--	--	--	0.1	--	--	0.7	4.9
Total	244.7	170.2	421.6	51.1	261.3	227.1	7.1	57.5	8820.2

Appendix Table 3. Invertebrate species catch composition (kg) for usable bottom trawl tows from the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004. Species with < 20 kg total catch (all tows combined) were included in "Other Invertebrates." For a complete list of all species captured, refer to Table 2.

	Catch (kg)										
Tow Number	1	2	3	4	5	6	7	9	13	14	15
Plumose anemone	4.6	0.7	0.2	1.1	9.6	5.2	4.1				
Dungeness crab	5.4	9.7	9.3	7.0	9.1	0.3	11.6				
Sunflower starfish	0.3								0.1		1.1
Pink short-spined star							0.4		0.4		6.6
Jellyfish											
Coonstripe shrimp											
Scallop									0.9	0.2	23.4
Cancer gracilis											
Other Invertebrates	0.3	0.2	0.4	0.0	0.2	0.0	1.2	0.0	4.1	0.3	5.5
Total	10.6	10.7	9.9	8.1	18.9	5.5	17.3	0.0	5.4	0.5	36.5

	Catch (kg)										
Tow Number	16	17	18	19	20	22	23	24	26	27	28
Plumose anemone											
Dungeness crab											
Sunflower starfish				7.6	3.0	0.3		0.5		0.7	3.2
Pink short-spined star						0.5	0 5			1.3	1.5
Jellyfish					8.3						
Coonstripe shrimp											
Scallop	0.1		0.5	0.1	0.1	0.1	0.1	0.1			
Cancer gracilis											0.1
Other Invertebrates	0.4	0.0	0.0	0.0	0.4	0.2	0.3	0.7	0.1	0.0	1.1
Total	0.5	0.0	0.5	7.7	11.8	1.1	0.9	1.2	0.1	2.1	5.9

	Catch (kg)										
Tow Number	29	30	31	32	33	34	35	36	37	38	39
Plumose anemone	3.8	5.0		100.5	5.0	1.6	7.5			4.9	3.4
Dungeness crab						10.9		1.3			
Sunflower starfish	1.7	6.4	2.9	0.4	2.4	9.0	0.3	0.4	1.2	0.2	
Pink short-spined star		0.3			6.0	8.4				0.8	0.2
Jellyfish						0.8					
Coonstripe shrimp	0.1	0.1	0.1								
Scallop											
Cancer gracilis			0.4		0.1	13.9	7.5	0.1			
Other Invertebrates	0.1	0.1	1.0	0.6	1.4	0.8	0.3	0.0	0.0	0.0	0.0
Total	5.7	11.9	4.4	101.5	14.9	45.5	15.6	1.8	1.2	5.8	3.6

Appendix Table 3. (Cont.)

	Catch (kg)										
Tow Number	40	41	42	43	44	45	46	47	48	49	50
Plumose anemone		1.1		3.8	2.1	2.0	1.6	7.6			0.3
Dungeness crab				8.9	0.3	5.1	21.6	1.8	1.0	4.9	0.7
Sunflower starfish		1.8	3.6	0.6			3.6		0.8		
Pink short-spined star	2.3		3.6			4.0	4.4				
Jellyfish											
Coonstripe shrimp						0.1		0.1	29.8	2.4	
Scallop											
Cancer gracilis											
Other Invertebrates	0.2	0.4	1.5	0.1	0.2	0.0	0.0	0.2	0.7	0.1	0.2
Total	2.5	3.3	8.7	13.5	2.6	11.2	31.2	9.7	32.3	7.4	1.2

	Catch (kg)										
Tow Number	51	52	53	54	56	57	58	59	60	61	62
Plumose anemone		2.7			22.9	1.9	21.1	11.2		1.1	
Dungeness crab	0.8			2.8				1.5			0.8
Sunflower starfish				0.1					0.3	0.7	0.1
Pink short-spined star	3.5		2.8	2.3							
Jellyfish						15.0	15.6	8.0			
Coonstripe shrimp			0.1	0.1							
Scallop											
Cancer gracilis											
Other Invertebrates	0.0	0.6	3.0	0.3	0.0	0.0	0.4	1.3	0.4	0.1	0.0
Total	4.3	3.2	5.8	5.6	22.9	16.9	37.1	21.9	0.7	2.0	0.9

	Catch (kg)								
Tow Number	63	64	65	66	67	68	69	70	All tows
Plumose anemone		1.8					0.8		239.2
Dungeness crab	1.1		0.3						116.2
Sunflower starfish	0.8							0.2	54.2
Pink short-spined star									49.8
Jellyfish									47.7
Coonstripe shrimp									32.9
Scallop									25.6
Cancer gracilis									22.1
Other Invertebrates	0.2	0.0	0.1	0.0	0.0	0.0	0.0	1.1	30.6
Total	2.1	1.8	0.4	0.0	0.0	0.0	0.8	1.3	618.4

Appendix Table 4. Length frequency (number of fish) for Pacific sanddab (*Citharichthys sordidus*), Rock sole (*Lepidopsetta bilineata*), and English sole (*Parophrys vetulus*) sampled during the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004.

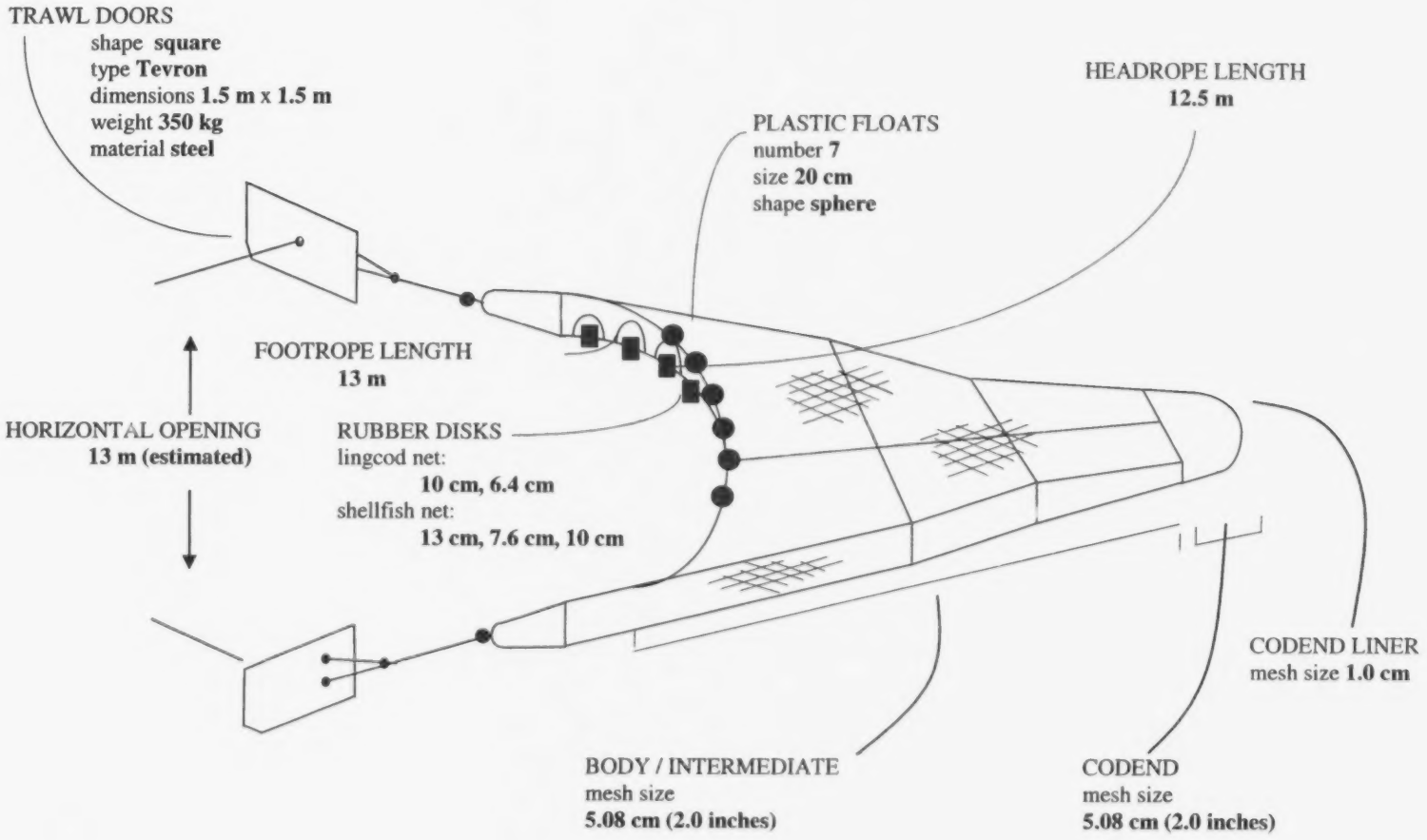
	Frequency				
	Pacific sanddab			Rock sole	English sole
Length (cm)	Males	Females	Total	Total	Total
4	--	--	--	--	--
5	--	--	--	--	--
6	--	--	--	--	--
7	--	--	--	--	--
8	--	--	--	--	--
9	--	--	--	13	--
10	--	--	--	34	--
11	--	--	--	42	--
12	--	--	--	29	3
13	--	--	--	11	5
14	--	--	--	39	23
15	--	--	--	14	32
16	--	--	--	28	44
17	--	--	--	22	68
18	--	--	--	11	56
19	--	--	--	13	60
20	1	--	1	11	42
21	1	--	1	10	38
22	1	--	1	15	30
23	1	--	1	12	39
24	3	--	3	10	29
25	5	1	6	10	23
26	10	1	11	7	17
27	10	2	12	11	21
28	2	2	4	15	15
29	--	6	6	9	8
30	--	4	4	16	10
31	--	5	5	11	5
32	--	5	5	6	5
33	--	0	0	5	5
34	--	1	1	4	3
35	--	--	--	1	4
36	--	--	--	2	5
37	--	--	--	0	1
38	--	--	--	1	0
39	--	--	--	--	0
40	--	--	--	--	0
41	--	--	--	--	1
42	--	--	--	--	--
43	--	--	--	--	--
44	--	--	--	--	--
45	--	--	--	--	--
Total	34	27	61	412	592

Appendix Table 5. Length frequency for Pacific tomcod (*Microgadus proximus*) and Walleye pollock (*Theragra chalcogramma*) sampled during the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004.

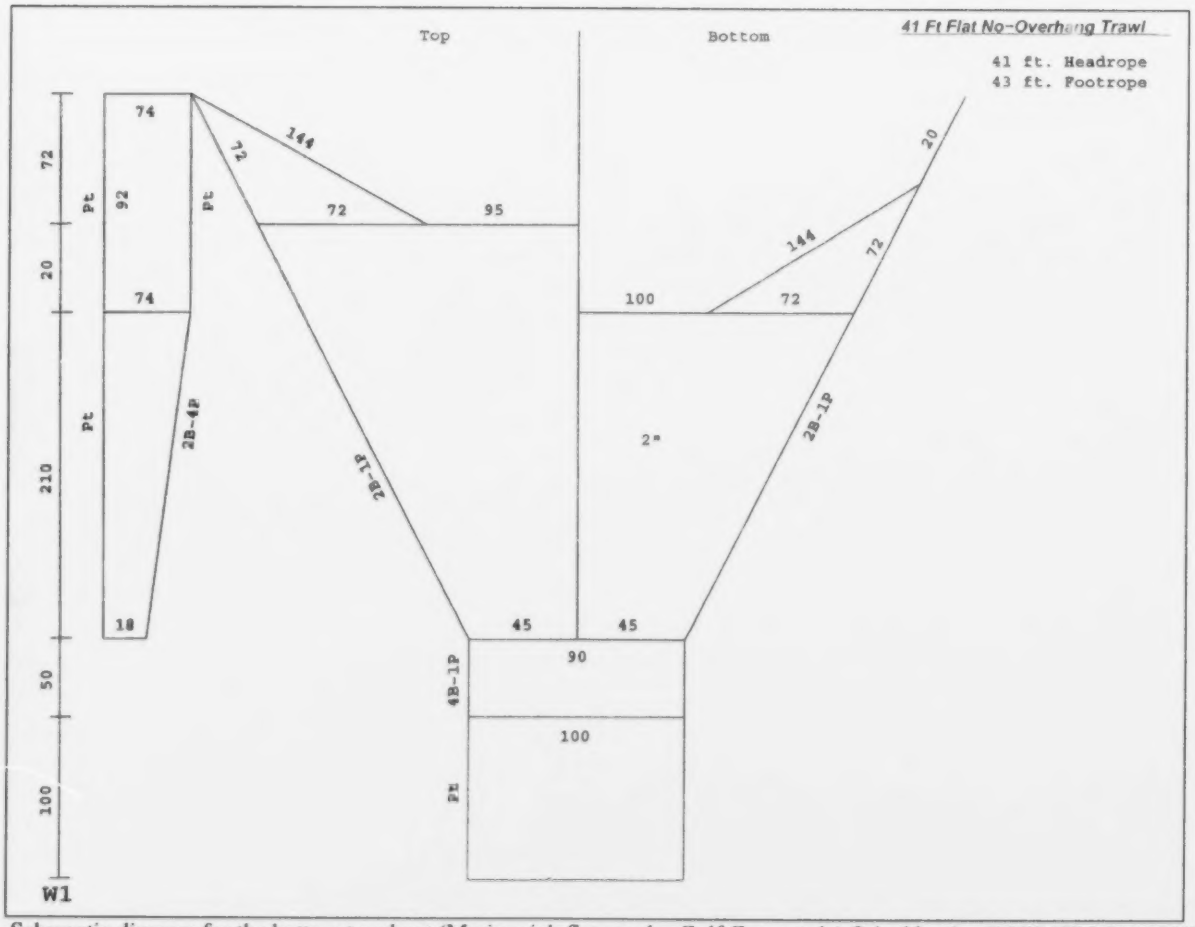
Length (cm)	Walleye pollock	Pacific tomcod
	Frequency	
4	--	--
5	--	--
6	--	--
7	--	6
8	--	32
9	3	53
10	20	37
11	66	10
12	16	12
13	--	0
14	--	0
15	--	1
16	--	0
17	--	3
18	--	7
19	--	8
20	--	7
21	--	3
22	--	1
23	--	0
24	--	2
25	--	2
26	--	1
27	--	--
28	--	--
29	--	--
30	--	--
31	--	--
32	--	--
33	--	--
34	--	--
35	--	--
36	--	--
37	--	--
38	--	--
39	--	--
40	--	--
41	--	--
42	--	--
43	--	--
44	--	--
45	--	--
Total	105	185

Appendix Table 6. Length frequency for Spiny dogfish (*Squalus acanthias*) sampled during the 2004 bottom trawl survey of young-of-the-year lingcod in the Strait of Georgia, on the *CCGS Neocaligus*, July 13 – 26, 2004.

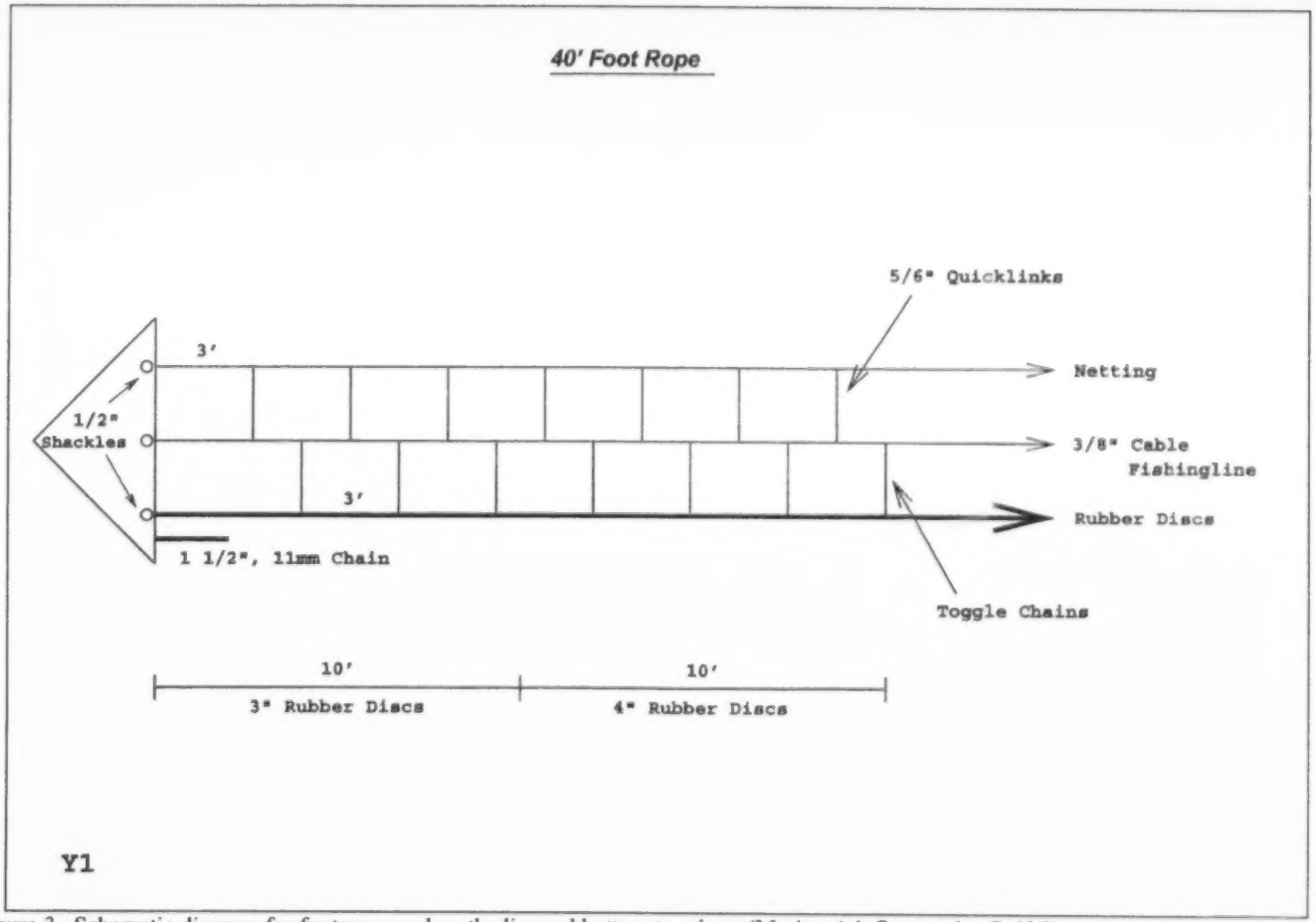
Length (cm)	Males	Females	Total
		Frequency	
43	--	--	--
44	--	--	--
45	--	--	--
46	--	1	1
47	2	0	2
48	1	1	2
49	1	3	4
50	2	4	6
51	1	2	3
52	2	2	4
53	1	2	3
54	4	1	5
55	3	1	4
56	2	0	2
57	1	4	5
58	1	0	1
59	1	1	2
60	1	0	1
61	0	0	0
62	2	0	2
63	0	0	0
64	0	1	1
65	1	1	2
66	0	1	1
67	2	0	2
68	0	1	1
69	0	1	1
70	0	0	0
71	0	2	2
72	1	0	1
73	1	1	2
74	0	0	0
75	0	0	0
76	1	0	1
77	0	0	0
78	0	0	0
79	0	0	0
80	0	1	1
81	1	--	1
82	--	--	--
83	--	--	--
84	--	--	--
85	--	--	--
Total	32	31	63



Appendix Figure 1. Net dimensions and characteristics for the bottom trawl net (Marinovich flat regular Gulf Coast style) fished by the *CCGS NEOCALIGUS* during the 2004 bottom trawl survey of Young-of-the-Year Lingcod (*Ophiodon elongatus*) in the Strait of Georgia, July 13 – 26, 2004.

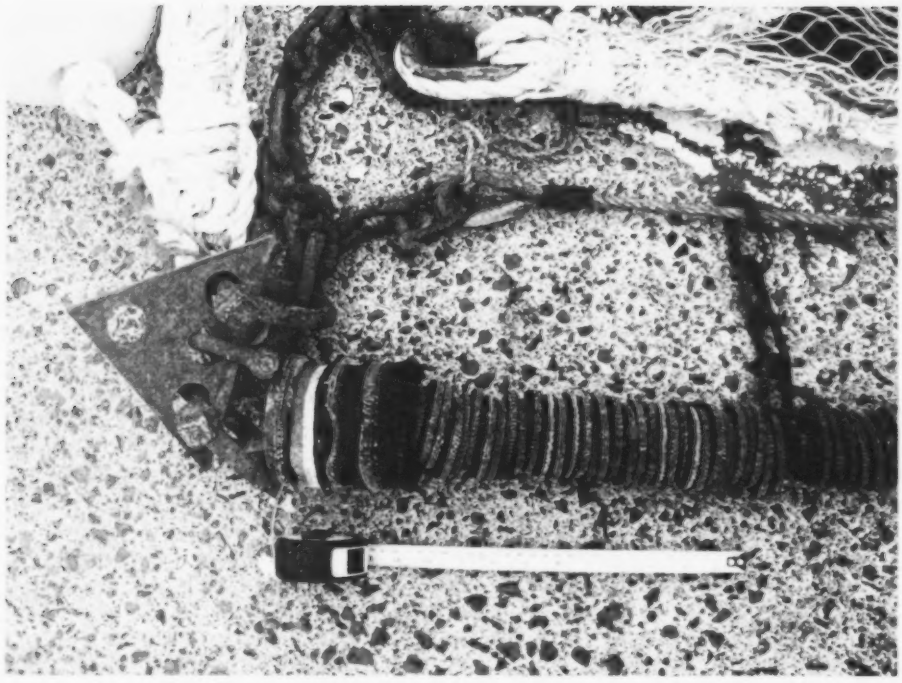


Appendix Figure 2. Schematic diagram for the bottom trawl net (Marinovich flat regular Gulf Coast style) fished by the *CCGS NEOCALIGUS* during the 2004 bottom trawl survey of Young-of-the-Year Lingcod (*Ophiodon elongatus*) in the Strait of Georgia, July 13 – 26, 2004. Diagram provided by Hugh's Rope and Nets, 2230 McGarrigle Road, Nanaimo, BC.

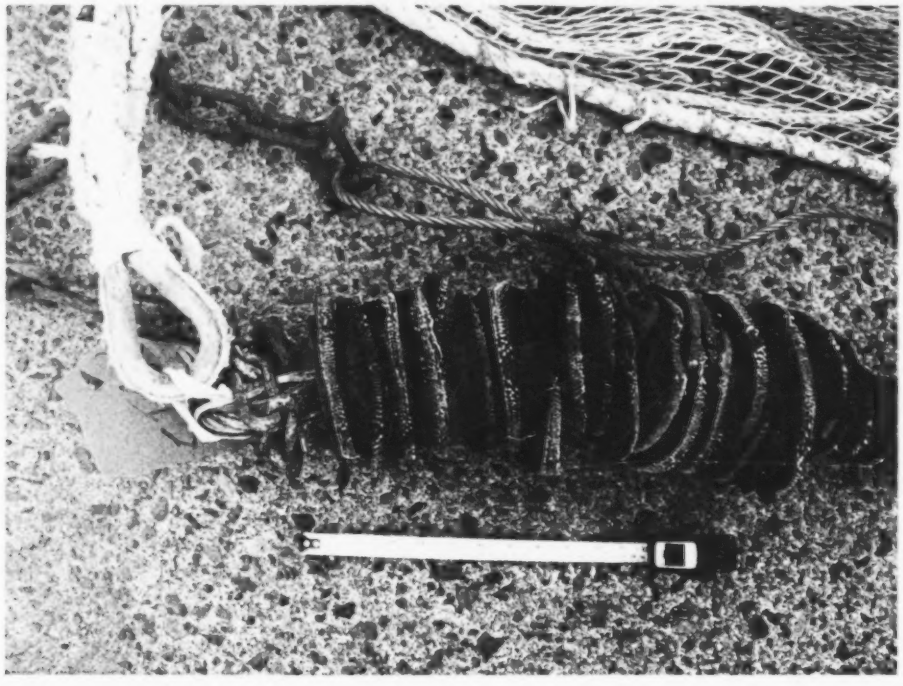


Appendix Figure 3. Schematic diagram for footrope used on the lingcod bottom trawl net (Marinovich flat regular Gulf Coast style) fished by the *CCGS NEOCALIGUS* during the 2004 bottom trawl survey of Young-of-the-Year Lingcod (*Ophiodon elongatus*) in the Strait of Georgia, July 13 – 26, 2004. Diagram provided by Hugh's Rope and Nets, 2230 McGarrigle Road, Nanaimo, BC.

A



B



Appendix Figure 4. Corners of the footropes of the two nets used in the net calibration experiment aboard the CCGS *Neocaligus*, August 22-23, 2004. A) Lingcod survey footrope; B) Shellfish survey footrope.